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Department of Energy

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AUG 21 1997

DOE-1326-97

Mr. James A. Saric, Remedial Project Manager
U.S. Environmental Protection Agency
Region V - SRF-5J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Thomas Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

SUBMITTAL OF ON-SITE DISPOSAL FACILITY IMPACTED MATERIALS PLACEMENT PLAN (REVISION H) AND SPECIALIZED PLACEMENT PLAN NO. 1 FOR OVERSIZED METALS AND OVERLENGTH STRUCTURAL STEEL BEAMS/COLUMNS

The letter submits the revised Impacted Materials Placement Plan, On-Site Disposal Facility (OSDF) (Revision H) and Specialized Placement Plan No. 1, Oversized Metals and Overlength Structural Steel Beams/Columns for the U.S. Environmental Protection Agency (U.S. EPA) and the Ohio Environmental Protection Agency (OEPA) review and approval.

The Impacted Materials Placement Plan has been revised to remove mention of the OSDF Air Monitoring Plan and to include a discussion on the control of fugitive dust emissions in accordance with the approved best available technology for the Department of Energy, Fernald Environmental Management Project (DOE-FEMP). Minor revisions were also made to the Plan to clarify the disposal prohibition on free liquids and the definitions of OSDF impacted material categories. Because first waste placement is currently scheduled to occur in October 1997, and approval of the Impacted Material Placement Plan is necessary by that time, DOE is available at any time to discuss issues or answer questions related to the Plan.

The Specialized Placement Plan No. 1 discusses the disposal of oversized materials in the OSDF. Focused discussions with EPA, OEPA, and local stakeholders on the on-site disposal of oversized materials took place on June 4, 1996, May 27, 1997, and June 24, 1997. DOE first proposed to place the following seven categories of oversized material into the OSDF:

- vessels;
- motors and generators;
- gear boxes;
- mill rolls;
- mill stand housings;
- machinery; and
- small white metal boxes.

It was estimated that these materials would have a volume of approximately 10,000 to 20,000 cubic yards, which is 0.4 percent to 0.8 percent of the estimated total volume of the OSDF (2.5 million cubic yards).

Due to concerns raised in the first meeting about the potential effect of the oversized material on the integrity of the OSDF liner system, GeoSyntec Consultants (the company that performed the design of the OSDF) was tasked with quantitatively evaluating the effect the above material categories would have on the OSDF liner system. GeoSyntec Consultants determined that the placement and permanent on-site disposal of these oversized materials would not have an adverse effect on the integrity of the OSDF.

In preparation for the May 27, 1997 meeting, DOE decided to revise their original proposal on the disposal of oversized material in the OSDF. It was determined that only those materials that could not be further disassembled or easily size reduced (i.e., solid pieces of metal) would be proposed for placement in the OSDF as oversized material. At the same time, it was determined that $1.6 million could be saved if structural steel (e.g., I-beams), which is currently planned to be cut into 10-foot pieces and disposed of in the OSDF, is left in 20-foot segments for disposal in the OSDF. In addition to the cost savings, another benefit to this proposal is that leaving the steel in 20-foot lengths increases the chance for recycling the metal instead of having to dispose of it. Therefore, at the May 27, 1997 meeting, DOE proposed that the following categories of oversized material be disposed of in the OSDF:

- mill rolls;
- mill stand housings;
- machine stands (including lathe beds); and
- 20-foot lengths of structural steel.

The estimated combined volume of the mill rolls, mill stand housings, and machine stands is 1,000 cubic yards, and the structural steel is estimated to be 2,500 cubic yards. The total estimated volume of oversized material proposed for disposal in the OSDF is 3,500 cubic yards, which is approximately 0.1 percent of the total volume of the OSDF. The oversized material that was previously proposed for disposal in the OSDF will now be size reduced to meet the size requirements for disposal in the OSDF (without needing any special placement provisions) or be sent off site for disposal.

The Specialized Placement Plan No. 1, Oversized Metals and Overlength Structural Steel Beams/Columns, describes the placement and compaction procedures for the four categories of oversized material listed above and once approved will become an addendum to the Impacted Materials Placement Plan. To facilitate your review of the Specialized Placement Plan, the quantitative evaluation on the effect of oversized materials on the OSDF liner performed by GeoSyntec Consultants is included for information in this transmittal. As stated above, this evaluation was performed for the original proposal of placing seven categories of oversized material in the OSDF. Because these calculations did not specifically address the 20-foot lengths of structural steel, GeoSyntec Consultants performed a separate evaluation following the June 24, 1997 public workshop. This evaluation concluded that overlength structural steel can be disposed in the OSDF without any adverse impact to the liner system, final cover system, or other engineered components of the OSDF. The letter discussing these conclusions is included as an attachment.

Please contact Jay Jalovec at (513) 648-3122 if there are any questions regarding these submittals or if you would like to schedule a meeting or a telephone conference.

Sincerely,

FEMP:Jalovec

Johnny W. Reising
Fernald Remedial Action
Project Manager

Enclosures: As Stated

cc w/enc:

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No.03

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IMPACTED MATERIALS PLACEMENT PLAN ON-SITE DISPOSAL FACILITY

20100-PL-007
Revision H
August 1997

United States Department of Energy

Fernald Environmental Management Project
Fernald, Ohio

Prepared by

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Under

Fluor Daniel Fernald
Subcontract 95PS005028

Attachment To: K-2288

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APPENDICES

1.0 INTRODUCTION

1.1 Overview

This Impacted Materials Placement (IMP) Plan describes the impacted materials acceptance, placement, compaction, and quality assurance/quality control (QA/QC) activities that will be undertaken throughout construction, filling, and closure of the On-Site Disposal Facility (OSDF) at the Fernald Environmental Management Project (FEMP), Fernald, Ohio.

1.2 Project Description

The OSDF will be constructed to contain impacted materials derived from remediation of the operable units at the FEMP. These materials will be required to meet OSDF waste acceptance criteria (WAC) prior to disposal in the OSDF. The estimated total volume of impacted material destined for OSDF disposal is 2.5 million cubic yards (1.9 million cubic meters) bank/unbulked. Approximately 80 percent of this material is impacted soil, with the remainder consisting of building demolition debris, flyash, lime sludge, municipal solid waste, and small quantities of miscellaneous other materials.

The construction, filling, and closure of the OSDF is currently scheduled to occur over a period of approximately seven years, as described in the Accelerated Remediation Plan [$276 million case] (276 Plan). However, due to the potential for variations in the pace of remedial action activities, the OSDF has been designed to be constructed, filled, and closed in phases for up to 25 years.

The design approach for the OSDF is presented in the document, *Final Remedial Design Work for Remedial Actions at Operable Unit 2 (OU2 RDWP)* [DOE, 1995c]. The design of the OSDF, as currently developed, is presented in the *Final Design Package, On-Site Disposal Facility* [GeoSyntec, 1997c]. The design of the OSDF includes a liner system, final cover system, leachate management system, and surface-water management system.

1.3 Plan Scope

This plan establishes the operational procedures to be used by the Subcontractor to place, compact, and protect impacted material placed in the OSDF. The scope of this IMP Plan includes:

- presenting radiological/chemical and physical waste acceptance criteria applicable to OSDF impacted materials;
- categorizing impacted material types based on handling, placement, and compaction requirements;
- developing acceptable proportions of the various impacted material types to be placed within any area of the OSDF to achieve satisfactory OSDF performance;

- developing procedures for placing and compacting impacted materials in the OSDF; and
- developing QA/QC procedures for impacted material placement in the OSDF.

1.4 Plan Organization

The remainder of this plan is organized as follows:

- the criteria used in establishing the requirements of this IMP Plan are presented in Section 2.0;
- the design features of the OSDF applicable to this IMP Plan are presented in Section 3.0;
- impacted material waste acceptance criteria are described in Section 4.0;
- descriptions of the impacted materials to be placed in the OSDF are presented in Section 5.0;
- general procedures for handling, placement, and compaction of impacted materials in the OSDF are presented in Section 6.0;
- specific procedures for handling, placement, and compaction of soil and soil-like impacted materials are presented in Section 7.0;
- specific procedures for handling and placement of special impacted materials are presented in Section 8.0;
- measures to be taken for the control of impacted runoff and fugitive emissions related to, or resulting from, the placement of impacted materials are described in Section 9.0;
- required documentation procedures are presented in Section 10.0;
- seasonal cover requirements are presented in Section 11.0; and
- regulatory and technical references cited in this plan are listed in Section 12.0.

Appendix A to this IMP Plan contains an Impacted Materials Placement (IMP) Quality Assurance Plan. The IMP Quality Assurance Plan describes those activities that the Construction Quality Control (CQC) Consultant will undertake to establish that the Subcontractor complies with this IMP Plan.

This IMP Plan uses several key phrases which are critical to the development of a complete understanding of the Plan. The terms and their usage within this plan are briefly explained as follows:

"lift"	usage common to earthwork
"grid"	refers to a 100 ft. by 100 ft. (30 m by 30-m) grid system for each cell, which provides the control for management of impacted material placement
"horizon"	a horizontal stratum limited horizontally to a 100 ft. by 100 ft. (30 m by 30 m) grid element, and limited vertically by either the maximum height of the item(s) therein or by the maximum number of lifts therein

1.5 Plan Responsibilities

This plan describes work to be conducted by three separate organizations:

- *Construction Manager (CM)* — Responsibilities include: overall coordination between all the parties to the FEMP; directing the construction management team; contractual management responsibility over the Subcontractor; specifying the materials requiring OSDF disposal; providing security for OSDF operations; implementing construction safety; providing emergency health and safety response teams; and oversite of the OSDF Construction Quality Assurance Plan.

- *Subcontractor* — Responsibilities include: separating impacted materials into categories; loading and hauling impacted materials to the OSDF; routing impacted materials within the OSDF battery limit; placing impacted material in the OSDF; obtaining final grade lines as shown on the Certified-For-Construction (CFC) Drawings; compacting (or compacting around and over) impacted material in the OSDF; and controlling the generation of fugitive emissions and managing impacted stormwater runoff.

- *CQC Consultant* — Responsibilities include: checking the Subcontractor's impacted material category classification; spot-checking impacted material shipments for conformance with the OSDF WAC prior to those shipments arriving at the OSDF battery limit; verifying the Subcontractor's choice of location for impacted material placement; documenting that the Subcontractor followed the placement and compaction procedures required by this IMP Plan; and conducting compaction tests of materials placed in the OSDF.

1.6 Related Plans

Several other plans have been prepared and should be used in conjunction with this IMP Plan. The other plans containing information relevant to this IMP Plan are listed below along with a brief statement of the relationship to this plan.

- *OSDF Construction Quality Assurance (CQA) Plan:* describes the quality assurance procedures that will be followed by CQC Consultant during construction, filling, and closure of the OSDF;

- *OSDF Systems Plan*: contains procedures for inspecting and monitoring the OSDF including the leachate management system, final cover system, and temporary facilities;

- *OSDF Surface Water Management and Erosion Control (SWMEC) Plan*: provides procedures for the management of surface water in and around the OSDF and details of temporary and permanent erosion and sediment controls for the OSDF; and

- *Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility:* establishes the strategies for ensuring that the OSDF WAC presented in this IMP Plan are met upon disposal in the OSDF.

The Subcontractor shall be responsible for preparing an IMP health and safety (H&S) plan that meets all health and safety requirements identified in the FEMP Project Specific Health and Safety Requirements Matrix (PSHSRM). In addition, the H&S personnel will perform periodic audits of the Subcontractor to ensure compliance; H&S personnel will have stop-work authority (in the event of threat to worker and/or public safety) until the proper corrective action is taken. The H&S Officer assigned to the OSDF project will be the single point of contact for all safety, industrial hygiene, fire protection, and radiological issues or concerns.

In addition to H&S personnel assigned to the project, the Subcontractor will be required to provide a H&S field representative who will be responsible for the Subcontractor's compliance with all H&S requirements. The Subcontractor will be required to report all safety concerns and incidents to the H&S Officer.

Radiological technician(s) will also be assigned to the OSDF project. In conjunction with the H&S Officer assigned to the project, the radiological technician(s) will help to ensure radiological compliance throughout the project. Radiological compliance includes the radiological monitoring of equipment and materials entering and leaving the job site, radiological monitoring of soil during excavations to help ensure proper segregation, storage, or disposition; radiation work permit compliance, routine inspection, monitoring, and recording of area radiation detection monitors, and radiological monitoring of personnel, if necessary. The PSHSRM will be the basis for the required monitoring and will identify the action levels that will ensure personnel safety by limiting exposure.

2.0 PERTINENT REQUIREMENTS

2.1 Overview

Regulatory and other requirements pertinent to this plan primarily take the form of applicable or relevant and appropriate requirements (ARARs) and to be considered criteria (TBCs) as determined by the record of decision for each of the various FEMP operable units, functional requirements, and general design criteria. In general, these criteria are intended to result in impacted material management activities that: (i) are protective of the OSDF liner system, leachate management system, and final cover system; (ii) result in an OSDF waste mass that is stable and does not undergo unacceptable levels of differential settlement; and (iii) provides acceptable management of the generation of fugitive emissions and the routing and containment of impacted runoff.

2.2 ARARs and TBCs

ARARs and TBCs that should be addressed by this plan are provided here, as obtained from the *Final Record of Decision for Remedial Actions at Operable Unit 2 (OU2 ROD)* [DOE, 1995a], the *Final Record of Decision for Remedial Actions at Operable Unit 5 (OU5 ROD)* [DOE, 1996a], the *Operable Unit 3 Record of Decision for Final Remedial Action (OU3 ROD)* [DOE, 1996b], or the *Permitting Plan and Substantive Requirements for the On-Site Disposal Facility (OSDF Permitting Plan)* [DOE, 1997a], as identified.

	Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	OSDF Permitting Plan
1	Ohio Particulate Matter Standards—Restriction of Emission of Fugitive Dust OAC 3745-17-08	Requires the use of reasonably available dust control measures to prevent fugitive dust from becoming airborne and defines "reasonably available control measures".	✓	✓	✓	
2	Ohio Solid Waste and Infectious Waste Regulations—Operational Criteria for a Sanitary Landfill Facility OAC 3745-27-19(E)(30)	Prohibits disposal of whole scrap tires and shredded whole scrap tires in a sanitary landfill facility.			✓	✓
3	Ohio Asbestos Emission Control—Standard for Active Asbestos Waste Disposal Sites OAC 3745-20-06	Prohibits visible emissions from asbestos-containing materials during placement, and requires at least 12 inches of cover of compacted non-asbestos containing material over that asbestos-containing material as soon as practicable but no less often than at the end of each operating day.			✓	✓

	Citation	Requirement	OU2 ROD	OU5 ROD	OU3 ROD	OSDF Permitting Plan
4	Ohio Asbestos Emission Control—Standard for Inactive Asbestos Waste Disposal Sites OAC 3745-20-07(A)&(C)	Prohibits visible emissions from asbestos-containing materials from an inactive asbestos waste disposal site, and requires at least 6 inches of cover of compacted non-asbestos containing material over that asbestos-containing material and growth and maintenance of a cover of vegetation on an area adequate to prevent exposure of the asbestos-containing waste material, or at least 2 feet of cover of compacted non-asbestos containing material, and maintenance of that cover to prevent exposure to the asbestos-containing waste material.	✓		✓	✓
5	Ohio Solid Waste and Infectious Waste Regulations—Sanitary Landfill Facility Construction OAC 3745-27-08(C)(6)	Requires placement of impacted materials to be performed such that the cell always stores runoff from active and open portions of the cell resulting from the 25-year, 24-hour storm event.	✓	✓	✓	✓
6	Radiation Protection of the Public and the Environment DOE Order 5400.5, Chapter I(4) and II(2)	Requires application of "As Low As Reasonably Achievable" (ALARA) goals to all activities in the excavation, removal, handling, and placement of impacted materials.	✓	✓	✓	

2.3 Functional Requirements

A variety of functional requirements have been established by DOE for the OSDF. The functional requirements applicable to this plan are given below:

- Facilities for impacted material management should:

    - be located in areas that can easily and efficiently accommodate receipt of impacted material from the various FEMP operable units;

    - be separated from clean areas;

- limit the uncontrolled discharge of fugitive emissions to acceptable levels;

- limit the generation of wastewaters to acceptable levels;

- comply with project health and safety requirements;

- be removed at the completion of impacted material management activities, with the disposal of affected materials in the OSDF; and

- be designed to minimize the generation of new impacted material.

- Impacted materials should be placed in the OSDF in a safe and cost-effective manner that prevents the uncontrolled release of impacted materials to the environment.

- This plan, in conjunction with the various operable unit remedial action planning documents, must only allow the placement of material satisfying the OSDF WAC.

2.4 General Design Criteria

A number of general design criteria have also been identified for the OSDF. The general design criteria applicable to this plan are:

- To the extent the stockpiling of impacted soil is necessary, the soil should be stockpiled in the FEMP former production area in order to use the existing storm drainage control system.

- Procedures should be employed that reduce the need for the use of respirators by on-site workers.

- Material transport procedures should cause minimal disturbance to the site and work area and be coordinated with impacted material removal and placement activities.

- Material transport equipment requirements should address the need to transport a variety of materials so that the number of pieces of equipment required to implement the design is minimized and should address the control of airborne particulate emissions.

- The Subcontractor must control the release of fugitive emissions (including dust, radiological, chemical, and asbestos materials) so that air quality standards are not violated on the site and so that releases are controlled to acceptable levels at the fence line.

- Acceptable emission control methods during placement operations include:

    - transport in dump trucks;

    - closed containers with metal or tarp lids;

- keeping impacted material moist; and
- spraying earthen material with a crusting agent when necessary;

- Impacted material placement procedures should take into account:
  - the rate and time at which impacted material will be available for placement in the cell;
  - the types of impacted material available for disposal (*i.e.*, soil, flyash, lime sludge, solid waste, or building demolition debris);
  - the potential for bulking/shrinkage of impacted material during placement;
  - the availability of temporary stockpile capacity;
  - the extent to which the disposal cell is constructed and available to receive impacted material; and
  - the need for suspended or reduced impacted material placement activities during winter and the need for seasonal (winter) cover.

- Impacted material placement activities should be organized to achieve the following objectives:
  - Impacted material should be placed in a manner that is protective of the liner system and final cover system.
  - Impacted material should be placed to minimize differential settlement to the extent reasonably achievable.
  - A minimum of 3 ft. (0.9 m) thickness of select impacted material should be placed directly over the protective layer component of the liner system, and beneath the contouring layer component layer of the final cover system, to provide protection of these systems from damage by impacted materials. The thickness of select impacted material over the protective layer may be decreased to 2 ft. (0.6 m) if the first lift of material to be placed over the select impacted material consists of soil or small size debris that can be placed in controlled lifts.
  - To limit particulate emissions, generation of wastewaters, and erosion of impacted material, the sequence of placement should minimize the area of exposed impacted material.
  - Materials should be placed in a manner that results in a disposal pile with relatively homogenous large-scale mechanical properties (*i.e.*, compressibility and shear

strength), to the extent possible; homogeneity should be achieved by distributing impacted materials throughout the OSDF to avoid large pockets or distinct concentrations of any one type of impacted material in a particular area; the objective is to minimize the potential for differential settlement.

- At the end of each work day, the impacted material surface should be graded and maintained to control precipitation runoff and impacted material erosion.

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3.0 OSDF FEATURES

3.1 General

The primary features of the OSDF related to the placement of impacted materials are the liner and final cover systems and certain support elements. These features are briefly described in this section. The Subcontractor shall be responsible for implementing the requirements of this section and for the protection and safety of the systems described in this section during OSDF construction, filling, and closure.

3.2 Impacted Materials Placement Zones

Control of the placement of impacted material in the OSDF during construction, filling, and closure is required in order to: (i) protect the OSDF liner system, final cover system, and leachate management system from damage; (ii) maintain the impacted material in a stable configuration; (iii) limit fugitive emissions to an acceptable level; (iv) allow containment of impacted runoff within the active OSDF cell; and (v) limit differential settlement of the OSDF final cover system to an acceptable level. Details of the liner system and final cover system proposed for the OSDF are shown on the CFC Drawings.

Within each OSDF cell, four zones exist in which impacted material may be placed. These zones and their relative locations with respect to the OSDF liner system and final cover system are shown in Figure 3-1. The four zones are as follows:

- *Protective layer* — a protective layer of impacted soil material shall be placed directly over the primary leachate collection system on the base of each OSDF cell; the soil used for the protective layer shall be either: (i) on-site till material with a maximum particle size not exceeding 3 in. (75 mm) (ASTM C 136); or (ii) granular drainage material meeting the material requirements of the project specifications and placed in specified areas of each cell to facilitate vertical percolation of impacted runoff into the underlying leachate collection system;

- *Select impacted material layer* — select impacted material shall be placed both on top of the protective layer and beneath the contouring layer to provide a physical barrier between debris and other "large-size" impacted material and the OSDF liner and final cover systems; the select impacted material shall consist of impacted soil or soil-like material with a maximum particle size not exceeding 6 in. (150 mm) (ASTM C 136);

- *Impacted material layers* — a variety of different impacted materials can be placed on top of the select impacted material layer in the central portions of an OSDF cell; the impacted material in this zone need only meet the radiological/chemical waste acceptance criteria established for the OSDF, the physical waste acceptance criteria established in this IMP Plan, and the placement and compaction criteria established in this IMP Plan; and

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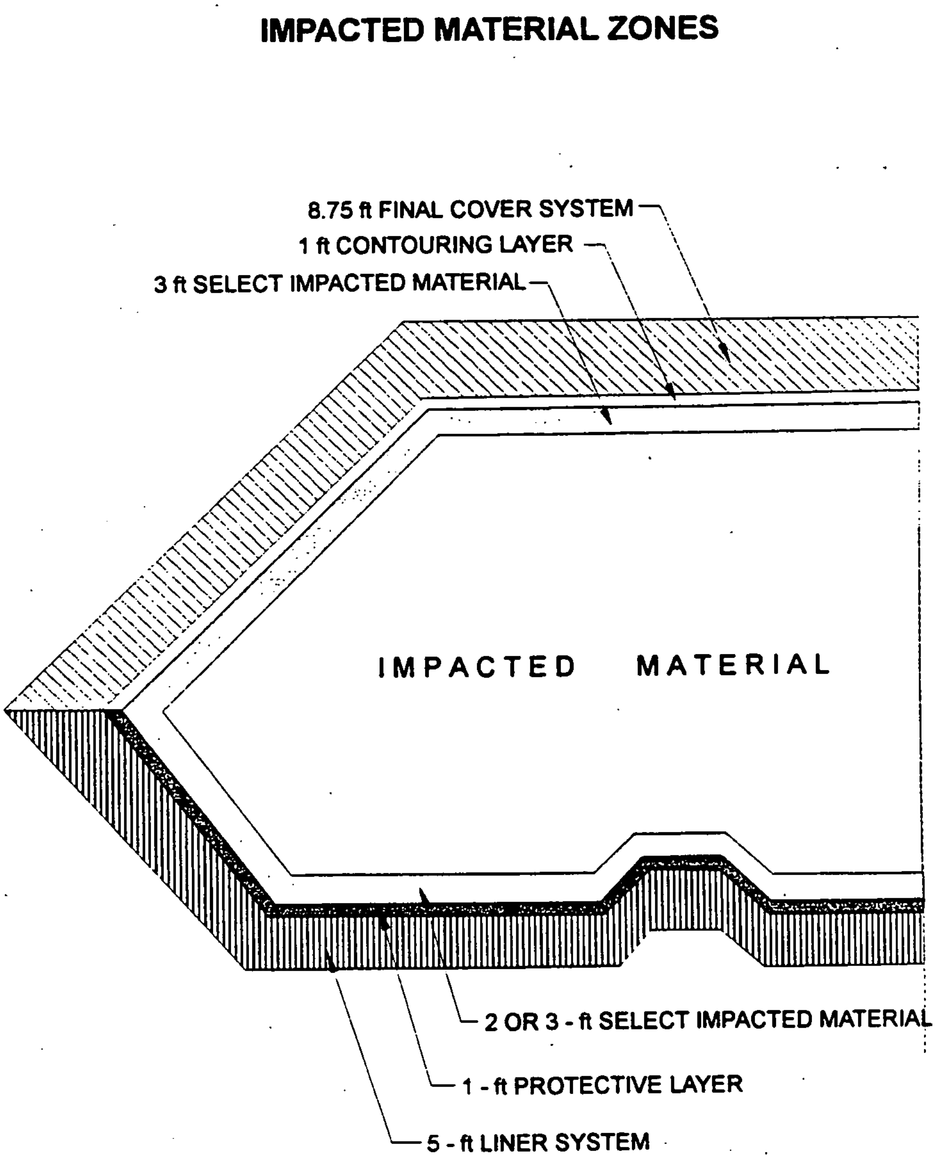

NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	3-1
PROJECT NO.	GQ0166-06
DOCUMENT NO.	F9620002.CDH
FILE NO.	FIG-6-3.CDR

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- *Contouring layer* — a contouring layer of impacted soil material shall be placed directly over the select impacted material layer, prior to installation of the OSDF final cover system; the soil used for the contouring layer shall be a till material with a maximum particle size not exceeding 3 in. (75 mm) (ASTM C 136).

3.3 OSDF Support Facilities

3.3.1 Impacted Material Haul Roads

The impacted material haul roads within the OSDF battery limit are designed to laterally contain material that may spill from trucks during transportation and also impacted runoff resulting from precipitation falling onto the roads. Trucks used for impacted material transport shall be suitable for the roadway design. Surfacing for the impacted material haul roads is designed to provide adequate support to the hauling units and a relatively tight texture to promote runoff. Surfacing materials used in the construction of impacted material haul roads shall be removed and disposed in the OSDF when the segment of roadway is no longer needed for impacted material placement activities.

Runoff from impacted material haul roads within the OSDF battery limit shall be managed as impacted runoff (*i.e.*, a form of wastewater). This water shall be contained, collected, and discharged to the storm drainage control system of the FEMP former production area, or to other on-site wastewater collection/conveyance points acceptable to the CM. Impacted material haul roads outside the OSDF battery limit are addressed as part of other plans prepared for the integrated FEMP remediation.

3.3.2 Impacted Soil Stockpile Areas

During initial construction of the OSDF, and periodically during filling and closure, it will be necessary to temporarily stockpile impacted soil resulting from OSDF excavation activities. An impacted soil stockpile area shall be developed to temporarily stockpile this material. The area used for stockpiling shall be graded flat and separated from surrounding areas by a 2 ft. (0.6 m) high soil berm. At the end of each day's work, the impacted soil stockpile shall be lightly compacted and rolled smooth to reduce precipitation infiltration into the pile and control fugitive emissions. Any stockpile that will remain inactive for more than 30 days shall be covered with either a crusting agent or geosynthetic cover. Grassing of impacted soil stockpile areas may be considered if the soil is suitable for establishment of a vegetative cover. Runoff from the stockpile shall be controlled and routed to the FEMP former production area storm drainage control system, or to other on-site wastewater collection/conveyance points acceptable to the CM.

Impacted soil excavated during construction of the first and subsequent OSDF cells and related support facilities shall be used for construction of the liner system protective layer and the select impacted material layer for those cells if meeting the requirements for those layers. Any geosynthetic cover used in the impacted soil stockpile area and other impacted soils from the operation shall be disposed in the OSDF as part of the impacted material placement activities described later in this plan.

3.3.3 Impacted Material Staging Areas

Impacted Material staging areas consist of gravel or concrete hardstands constructed to temporarily store impacted structural members and other building demolition debris. These areas will be used to temporarily stage any material not able to go directly from the material source to an active OSDF cell. Impacted material staging areas constructed outside the limits of the FEMP former production area shall have positive runoff control. Any runoff from these areas will be directed to the storm drainage control system of the FEMP former production area or to other on-site wastewater collection conveyance points acceptable to the CM.

4.0 WASTE ACCEPTANCE CRITERIA

4.1 General

This section of the IMP Plan presents information regarding the waste acceptance criteria applicable to the OSDF. Radiological/chemical waste acceptance criteria developed by the individual operable units at the FEMP are identified and made a part of this plan. Other physical criteria are established in this plan.

4.2 OSDF Chemical/Radiological Waste Acceptance Criteria

The *Final Record of Decision for Remedial Actions at Operable Unit 2 (OU2 ROD)* [DOE, 1995a] has established a radiological waste acceptance criteria of 346 picoCuries/gram (pCi/g) of uranium-238 or 1,030 milligrams per kilogram (mg/kg) of total uranium for operable unit remediation materials destined for the OSDF. Similarly, the *Final Record of Decision for Remedial Actions at Operable Unit (OU5 ROD)* [DOE, 1996] established additional radiological and chemical waste acceptance criteria for Operable Unit 5 remediation soils destined for the OSDF. Similarly, the *Operable Unit 3 Record of Decision for Final Remedial Action (OU3 ROD)* [DOE, 1996b] has established a radiological waste acceptance criteria of 105 grams technetium-99 for Operable Unit 3 remediation debris materials. These waste acceptance criteria have been compiled and are presented in Table 4-1. The remediation materials sent to the OSDF from Operable Unit 3 (see Table 5-1) may also include small material contributions from Operable Units 1 and 4; any structural debris material resulting from decontamination and deconstruction of the remediation facilities from these latter operable units destined for the OSDF must meet the Operable Unit 3 waste acceptance criteria.

4.3 Physical Criteria

The physical criteria (dimensions given are considered nominal) that shall be applied to material destined to the OSDF are:

- materials from various building components (*i.e.*, steel, concrete, masonry rubble, finish components, *etc.*) shall be segregated at the staging area by the Subcontractor;

- the maximum length of irregularly shaped metals or other components of a building superstructure or finish component shall be 10 ft. (3 m);

- the maximum thickness of irregularly shaped metals or other components of a building superstructure or finish component shall be 18 in. (450 mm);

- the maximum thickness of concrete or other components of a building slab or substructure shall be 18 in. (450 mm) when the materials are part of a load of similar material;

Table 4-1
ON-SITE DISPOSAL FACILITY
WASTE ACCEPTANCE CRITERIA

		Soils		Debris
	Constituent of Concern	**OU2**	**OU5[d]**	**OU3**
	Radionuclides:			
1	Neptunium-237		3.12×10^{9} pCi/g	
2	Strontium-90		5.67×10^{10} pCi/g	
3	Technetium-99		29.1 pCi/g	105 g
4	Uranium-238	346 pCi/g		
	Total Uranium	1,030 mg/kg	1,030 mg/kg	
	Inorganics:			
5	Boron		1.04×10^{3} mg/kg	
6	Mercury[c]		5.66×10^{4} mg/kg	
	Organics:			
7	Bromodichloromethane		9.03×10^{-1} mg/kg	
8	Carbazole		7.27×10^{4} mg/kg	
9	Alpha-chlordane		2.89 mg/kg	
10	Bis(2-chloroisopropyl)ether		2.44×10^{-2} mg/kg	
11	Chloroethane		3.92×10^{5} mg/kg	
12	1,1-Dichloroethene[c]		11.4 mg/kg	
13	1,2-Dichloroethene[c]		11.4 mg/kg	
14	4-Nitroaniline		4.42×10^{-2} mg/kg	
15	Tetrachloroethene[c]		128 mg/kg	
16	Toxaphene[c]		1.06×10^{5} mg/kg	
17	Trichloroethene[c]		128 mg/kg	
18	Vinyl chloride[c]		1.51 mg/kg	

NOTES:
[a] maximum concentration
[b] maximum total mass
[c] RCRA-based constituent of concern
[d] constituents which have established maximums which serve as Waste Acceptance Criteria; other compounds which will not exceed designated Great Miami Aquifer action levels within 1000-year performance period, regardless of starting concentration in the OSDF, are not listed.

SOURCES:
OU2 ROD [DOE, 1995a]
OU5 ROD [DOE, 1996a]
OU3 ROD [DOE, 1996b]

- the maximum cross-sectional dimension of an individual concrete member or other component of a building slab or substructure shall be 4 ft. (1.2 m) when the item is handled individually and is a regular, rectangular shape having no concrete protrusions greater than 18 in. (450 mm);

- concrete reinforcement bars shall be cut within a nominal 12 in. (300 mm) of the concrete mass;

- the maximum thickness of uniform pallets of building cladding (*e.g.*, transite panels) properly banded into rectangular shapes shall be 4 ft. (1.2 m);

- regulated asbestos containing material (ACM) shall be double-bagged at the source and delivered unmixed with other materials;

- ACM brick and commingled debris shall be double-contained and segregated at the source;

- piping having insulation of ACM shall be segregated at the source and delivered unmixed with other materials;

- general building rubble consisting of wood, drywall, HVAC systems, electrical systems, plumbing systems, and minor equipment shall be sufficiently reduced in size to be gradeable into a 18 in. (450-mm) lift by equipment similar to a Caterpillar D-8 bulldozer;

- equipment shall be drained of all oils and liquids;

- piping with a nominal diameter of 12 in. (300 mm) or greater will be split in half; and

- the maximum dimension of general building rubble consisting of concrete, masonry, and other similar materials shall be 18 in. (450 mm).

Impacted materials brought to the OSDF should not be at such a high moisture content that impacted material placement and compaction activities are impeded. Generally, soil should have a moisture content that allows the material to be compacted to the required relative compaction using standard soil compaction equipment and procedures. Soil should also have a moisture content that does not result in excessive "bleeding" of liquids. As necessary, the CM will direct the Subcontractor to dry the soil by disking and air drying, by blending with drier soil, or by other means so that the soil can be compacted to the required percent of standard Proctor dry density. The Subcontractor shall limit the use of in-cell drying to the extent necessary to not restrict the placement of impacted material in the OSDF.

4.4 Prohibited Items

The following are specifically prohibited from disposal in the OSDF:

- impacted material exceeding WAC presented in Table 4-1;

- impacted material that is "characteristically hazardous" ("RCRA characteristic waste"), as defined in the OU2, OU3, and OU5 ROD (Excluded from this prohibition is impacted material that has been treated so that it is no longer "characteristically hazardous".);

- material from any off-site source, including any other DOE site, except as provided in the *OU5 ROD*, which states *"Specifically excluded from this prohibition are laboratory wastes generated at off-site facilities resulting directly from the chemical, radiological and engineering analysis of FEMP waste materials/contaminated media or wastes generated at off-site facilities during the conduct of treatability or demonstration type studies on FEMP material";*

- pressurizable gas cylinders;

- process-related metals (OU3-ROD Category C materials);

- product, residues, and other special materials (a subset of OU3-ROD Category J materials);

- materials containing free liquids (The intent of the exclusion of free liquids is to prevent contaminated liquid waste from being directly disposed of in the OSDF (e.g., drum of solvent). Materials that contain rainwater or that have an inherent moisture content like sludges are not excluded from disposal in the OSDF. If a material that arrives at the OSDF for disposal is too wet for proper placement and compaction, the material will be mechanically processed before placement.);

- intact drums (*i.e.*, drums must be empty and crushed);

- acid brick (OU3-ROD Category F materials);

- transformers, which have not been either crushed or had their void spaces filled with grout (or other material approved by the CM);

- whole or shredded scrap tires;

- used oils; and

- materials not accompanied by the transportation "manifest" information specified in this plan.

5.0 IMPACTED MATERIAL DESCRIPTIONS

5.1 General

The OSDF will be the final repository for a majority of the impacted material from the five operable units of the integrated FEMP remediation. Construction debris (*i.e.*, waste originating during the construction of the OSDF) will also be disposed in the OSDF. The materials requiring OSDF disposal are expected to vary considerably in their composition, handling, placement, and compaction characteristics. Given this variability, it is useful to develop a categorization framework wherein materials with similar characteristics are assigned to the same category. The purpose of this section of the IMP Plan is to describe and categorize the various impacted materials using a common categorization framework.

5.2 Impacted Material Categories

Impacted materials to be disposed in the OSDF shall be assigned to one of five categories, depending on the procedures that will be used to place them into the OSDF:

Category 1 - Category 1 impacted materials are soils and soil-like materials that do not contain hard agglomerations greater than 12 in. (300 mm) in greatest dimension. If the material is other than till or ash from the FEMP site, the material in this category must also have at least 80 percent of its particles finer than a 1 in. (25 mm) particle size. If this latter criterim is not met, the material should be classified as a Category 2 material. These impacted materials are expected to be readily compatible using standard construction equipment.

Category 2 - Category 2 impacted materials are materials that can be transported, placed, spread, and compacted *en masse*. These materials can be spread in loose lifts of 18 to 21 in. (450 to 530 mm) thick and are moderately compatible under the action of equipment similar to the Caterpillar D-8 bulldozer or 815C compactor. Examples of these materials include broken-up concrete foundations or impacted soil mixed with broken-up concrete. This category also includes general building rubble and debris of irregularly shaped metals or other components of the superstructure or substructure with a maximum length of 10 ft. (3 m) and a maximum thickness of 18 in. (450 mm) which can be transported, placed, spread, and compacted *en masse*.

Category 3 - Category 3 impacted materials are materials that must be individually handled and placed in the OSDF, and that are suitable for having Category 1 material placed around and against them. These impacted materials have maximum cross-sectional dimension of no more than 4 ft. (1.2 m), are shaped such that Category 1 material to be compacted around and against them, and are essentially incompressible using standard compaction equipment. Examples of these materials include structural steel beams/columns, bundles of transite panels, and broken concrete foundation members that meet the physical criteria defined in Section 4.3 of this IMP Plan.

Category 4 - Category 4 impacted materials are high in organic content and/or very compressible. Examples of these materials are municipal solid wastes from the Solid Waste Landfill, and green waste from clearing, stripping, and grubbing operations around the FEMP.

Category 5 - Category 5 impacted materials are materials that require special handling due to their specific nature. Examples of these materials include double-bagged asbestos and sludges.

The categories given above shall be used by the Subcontractor to categorize each load of impacted material to be brought to the OSDF for disposal. The CM will use this categorization in establishing disposal limitations and instructions for each truck load of material destined for the OSDF.

5.3 Specific Impacted Materials

5.3.1 General

This section of the IMP Plan contains background information on the types and approximate quantities of specific impacted materials that may require special handling and/or placement activities. These impacted materials primarily consist of landfill waste, water treatment plant sludge, and demolition debris. The purpose of this section of the IMP Plan is to provide the Subcontractor with a physical description of these specific materials.

5.3.2 Solid Waste Landfill

The Solid Waste Landfill is a rectangular disposal area of approximately 1 acre (0.4 ha) that has been inactive since 1986. A soil cover has been placed over the disposal area. A drainage ditch serving the northwest portion of the former production area is located in the northern portion of the Solid Waste Landfill. The volume of waste material in the landfill is estimated to be approximately 14,400 yd^3 (11,000 m^3).

The operational history of the Solid Waste Landfill is not well documented. It is thought that the landfill was organized with one to five individual waste disposal cells and an evaporation pond which also served as a surface-water management basin. Materials reportedly buried at the Solid Waste Landfill include non-burnable and nonradioactive solid wasted generated on FEMP property, nonradioactive construction-related rubble, and double-bagged and bulk quantities of nonradioactive asbestos. Field investigation results, however, indicate that some process waste may have been placed in the landfill. The following wastes were encountered during a trenching investigation in 1992:

- burnable wastes - bagged trash and wood;

- potentially burnable wastes - respirator cartridges, asphalt roofing materials, medical wastes, firehoses, and rubber hoses/belts; and

- non-burnable wastes - unidentified high-activity waste, medicine vials, bagged asbestos, ceramic tiles, possible magnesium fluoride, glass acid bottles, steel cables/cans, paint cans, and copper tubing.

5.3.3 Lime Sludge Ponds

The Lime Sludge Ponds are two unlined, rectangular ponds, each measuring approximately 125 by 225 ft. (38 x 69 m). Wastes that were disposed in the Lime Sludge Ponds originated from water treatment plant operations, coal pile stormwater runoff, and boiler plant blowdown. Although this waste is from three distinct waste streams, the bulk of the slurry is lime sludge from the water treatment process. Over time, the solids in the slurry settled in the Lime Sludge Ponds and the remaining decant was pumped from the ponds. The lime sludge is, therefore, considered to be relatively homogenous.

The volume of sludge and berm material contained within the two lime sludge ponds is estimated to be approximately 16,500 yd^3 (12,500 m^3) of lime sludge and 5,600 yd^3 (4,300 m^3) of berm material making a total of 22,100 yd^3 (17,100 m^3) of material. The South Lime Sludge Pond is full and has been inactive since the mid-1960's; it is now overgrown with grasses and shrubs. The North Lime Sludge Pond is not currently active, but was in use as late as January 1995. The west side of the North Lime Sludge Pond is usually covered with 1 to 2 ft. (0.3 to 0.6 m) of water, depending mainly on precipitation. The remaining area is dry and covered with sparse vegetation.

5.3.4 Building Debris

Debris from demolition of buildings in the FEMP former production area is expected to constitute the largest volume of impacted material for OSDF disposal after soil and soil-like material. The *Operable Unit 3 Record of Decision for Final Remedial Action (OU3 ROD)* [DOE, 1996b] indicates that impacted debris can be assigned to one of ten material categories. The *OU3 ROD* indicates that material from seven of these categories will be disposed in the OSDF; material from three other categories (C, F, and J) are to be dispositioned off-site (*i.e.*, expressly prohibited in total from on-site disposal), while a subset of a third category (D) cannot be disposed in the OSDF without first undergoing treatment (lead flashing). Description of the seven OU3 debris material categories resulting from decontamination and deconstruction of the former production and associated process facilities that can be disposed of in the OSDF are defined in Table 5-1.

Table 5-1
OU3 Material Categories/Descriptions

Category A Accessible Metals	Category B Inaccessible Metals	Category D Painted Light-Gauge Metals	Category E Concrete	Category G Non-Regulated ACM	Category H Regulated ACM	Category I Miscellaneous Materials
Structural & miscellaneous steel	•Doors •Conduit/wire/ cable tray •Electrical wiring & fixtures •Electrical transformers •Miscellaneous electrical items •HVAC equipment •Material handling equipment •Process equipment •Miscellaneous equipment •Piping	•Ductwork •Louvers •Metal wall & roof panels	•Asphalt •Slabs •Columns •Beams •Foundations •Walls •Masonry •Clay piping	•Ceiling demolition •Feeder cable •Fire brick •Floor tile •Transite wall & roof panels	•Ductwork insulation •Piping insulation •Personal protective equipment •Copper scrap metal pile	•PVC conduit •Basin liners •Fabric •Drywall •Building insulation •Miscellaneous debris •Personal protective equipment •PVC piping •Roofing build-up •Process trailers •Non-process trailers •Windows •Wood

SOURCE: Table 4-2, OU3 Material Categories/Description, *OU3 ROD* [DOE, 1996b].
NOTE: Only those OU3 material categories allowed in total for on-site disposal per the *OU3 ROD* are presented.

5.3.5 Inactive Flyash Piles

The Inactive Flyash Pile is located approximately 2000 ft. (610 m) southwest of the former production area. The Inactive Flyash Pile received flyash and bottom ash from boiler plant operations starting in 1951. It has been inactive since the mid-1960s and is covered with soil and natural vegetation. The total quantity of ash disposed in this area has been estimated at 43,600 yd^3 (33,300 m^3). Materials such as building rubble, concrete, asphalt, steel rebar, and asbestos containing transite were also discarded in this area. These materials are visible at the surface along the Inactive Flyash Pile's western and southern edge.

5.3.6 South Field

The South Field disposal area is located approximately 2000 ft. (610 m) southwest of the former Production Area and covers approximately 11 ac (4.5 ha). The South Field was used as a burial site for construction rubble and as a disposal area for soil excavated from the former Production Area. Disposal activity ceased during the mid 1960s. Soil, building rubble, concrete, asphalt, flyash, and steel rebar were encountered during sampling operations within the soil fill in the South Field. The estimated volume of fill disposed in the South Field is approximately 120,000 yd^3 (91,800 m^3).

5.3.7 Active Flyash Pile

The Active Flyash Pile disposal area is located about 3000 ft. (914 m) southwest of the former Production Area and east of the South Field. Past operations at the FEMP have relied on boiler-produced steam. Ash waste is comprised primarily (70 percent) of bottom ash collected below the boilers. Precipitator ash collected from pollution control devices and flyash removed from the middle levels of the boiler comprise the remaining 30 percent of the ash waste. Until recently, ash waste has been loaded into dump trucks and transported to the Active Flyash Pile disposal area. Estimates established indicate that approximately 65,000 yd^3 (49,700 m^3) of ash have been disposed in this area. The pile has a surface area of approximately 4 ac (1.6 ha).

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6.0 GENERAL PLACEMENT PROCEDURES

6.1 Introduction

This section of the IMP Plan describes the general procedures that the Subcontractor shall follow for placement of impacted material in the OSDF. Specific procedures for placement of Category 1 materials (soil and soil-like) are presented in Section 7.0 of this IMP Plan. Specific placement procedures for Category 2 through 5 materials (non soil-like materials) are addressed in Section 8.0 of this IMP Plan.

6.2 Manifesting

The remediation project originating the impacted material shall prepare an impacted material transportation "manifest" for each load of material to be transported to the OSDF. The purpose of the "manifest" is to provide a tracking mechanism for impacted material from the remediation project of origin to placement in the OSDF. The originating remediation project shall be responsible for providing the following information on the "manifest":

- originating remediation project (the operable unit and project);

- brief description of the impacted material in the load;

- classification of the impacted material into one of the five material categories of this IMP Plan; and

- documentation that the material meets the criteria in Section 4.0 of this IMP Plan.

The CQC Consultant shall be responsible for recording on the "manifest":

- the OSDF cell identifier where the material is placed.

The Subcontractor shall develop a system acceptable to the CM for identifying the category of impacted material being hauled. This system shall indicate the category of material in the truck (or container as appropriate) and whether the truck/container is carrying special items such as asbestos, extremely heavy items, extremely compressible items, impacted materials requiring special dust mitigation procedures, sludge, or landfill waste.

At the OSDF battery limit, each truck load (or container, as appropriate) of impacted material will be monitored by the CQC Consultant in accordance with Appendix A of this plan. The monitoring will include monitoring for asbestos, visual verification that the impacted material matches the description on the manifest, visual checking that the material meets the OSDF physical criteria, and visual checking that prohibited items are not included in the load. The CQC Consultant will be required to sign the "manifest" and retain a copy. The Subcontractor shall fully comply with these quality control activities and account for them in its planning and scheduling.

After trucks/containers are cleared at the OSDF battery limit, the Subcontractor shall route the impacted material to a location within the OSDF (*e.g.*, the active face, a stockpile area, or an area where further screening will take place) for disposal. The Subcontractor will be provided with flexibility in routing trucks/containers for efficient operations. However, the CM will provide the Subcontractor with specific instructions for routing of impacted materials in Categories 2 through 5. The Subcontractor shall be responsible for following these instructions.

The placement and compaction procedure to be used by the Subcontractor for each load of impacted material shall be based on the impacted material category. Placement and compaction procedures for the five material categories listed in Section 5.2 of this IMP Plan are presented in Sections 7.0 and 8.0 of this plan.

6.3 Protection of Facilities

Impacted material placement activities shall be conducted in a manner that protects and maintains the integrity of the OSDF liner system, leachate management system, and final cover system, and all OSDF ancillary facilities and equipment. Impacted material placement activities shall not commence in a cell until liner system construction has been completed in accordance with the contract documents and only after cell construction has been certified in accordance with the requirements of the *OSDF CQA Plan* and all other subcontract requirements.

6.4 Placement Oversight and Quality Assurance

Impacted material placement for all categories of material shall be conducted under the direct oversight of Subcontractor personnel versed in all aspects of this plan and having qualifications meeting the requirements of the *OSDF CQA Plan*. The Subcontractor shall provide on-the-ground spotters who shall observe each load that is placed to monitor that the work is performed in compliance with the requirements of this plan. The Subcontractor shall be assisted by surveyors and quality control personnel, as required, to control lift thickness and grades, record the coordinates of the impacted material placement, and perform other necessary functions.

The Subcontractor shall be aware that monitoring of the placement and monitoring and testing of impacted material for specified compaction in the OSDF will be performed by the CQC Consultant in accordance with the requirements of the contract documents.

6.5 Conformance with OSDF Specifications

The Subcontractor shall comply with the project specifications, which shall be used in conjunction with this plan, and these shall be referenced for specific details regarding the labor, material, and supervision at the OSDF.

6.6 Standard Operations Procedures

6.6.1 General

The CM will have the authority to halt impacted material placement operations if placement operations are not in accordance with the project specifications and this IMP Plan.

Salvaging of materials being deposited in the OSDF is strictly prohibited. Fluor Daniel Fernald (FDF) personnel will examine, on a random basis, trucks leaving the OSDF for salvaged materials.

Placement of impacted materials shall only occur during daylight hours unless specifically approved by the CM. The last unit load of waste typically will not be accepted less than 45 minutes prior to sundown.

Impacted material placement activities shall cease for the winter when the CM determines that satisfactory compaction of impacted material and/or safe working conditions are no longer possible due to weather conditions.

6.6.2 Inclement Weather Operations

Placement of impacted material in the OSDF shall cease when the average wind speed measured at or near the working face of the active OSDF cell is in excess of 20 mph (33 kph) or when wind gusts exceed 30 mph (50 kph) for more than 1 minute in the previous 60 minutes. The CQC Consultant or FDF will provide and maintain a weather station at or near the active working face of the OSDF to provide a continuous record of windspeed and temperature during the working day; the station will also be equipped with a rain gauge. The CM will determine when unacceptable wind conditions exist.

Impacted material shall not be placed during periods of significant precipitation. Significant precipitation will be determined by the CM in consultation with the CQC Consultant.

The Subcontractor may prepare an inclement weather deck within the OSDF active cell. The purpose of this deck is to provide an area where placement activities can occur when precipitation has left other areas of the OSDF unsuitable (due to mud or soft surfaces) for impacted materials placement activities. The inclement weather deck may be used for placement of Category 2 materials (*en masse* placement).

Impacted material placement activities shall not restart after an inclement weather shutdown until verbal approval to do so is provided by the CM. Factors that will be considered by the CM in restarting operations include:

- weather forecasts;
- condition of haul roads;
- if operations could lead to additional erosion of impacted materials;
- ability to decontaminate the impacted material hauling trucks;

- nature of impacted materials to be placed; and
- conditions within the OSDF.

6.6.3 As-Placed Plans

The Subcontractor shall be aware that the CQC Consultant will maintain plans showing the locations of placement of all Category 3 through 5 impacted materials. The plans will provide the OSDF cell, grid and lift alphanumeric identifier for each load of material placed in the OSDF (referenced to the load manifest number), the category of material in the load, and other information. The CM will use these plans to decide where subsequent loads of special category waste can be placed. For example, the Subcontractor will not be allowed to compact multiple lifts of Category 4 (organic) impacted material on top of each other so as to avoid creating a compressible zone in the OSDF that could induce future differential settlements in the OSDF final cover system.

6.7 Spreading and Grading

The Subcontractor shall be aware that an important objective of this IMP Plan is to achieve uniform settlement of the impacted materials placed within the OSDF and to limit the total magnitude of such settlement. Thus, the Subcontractor shall, as much as possible, maintain homogeneity of the physical characteristics of the impacted materials placed across horizons of the OSDF. The Subcontractor will be directed by the CM to route impacted materials in such a fashion that each lift is relatively uniform over its lateral extent. To the extent possible, compressible materials (such as green wastes, double bagged asbestos, and Solid Waste Landfill materials) shall not be piled vertically but shall be spread laterally (except for double bagged asbestos, which shall be handled in accordance with Section 8.6.3). Incompressible materials shall not be placed directly above other incompressible items without appropriate intervening lifts of Category 1 materials. Materials of higher permeability (such as demolition debris) shall not be placed directly above other high permeability materials without appropriate intervening lifts of lower permeability materials.

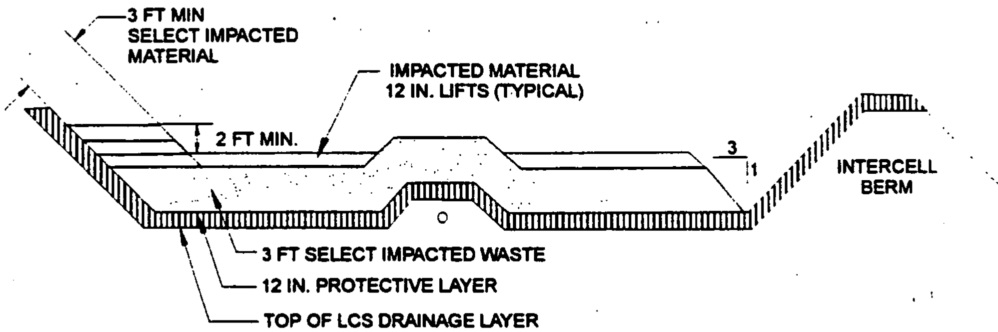
Impacted material placement shall generally proceed from east to west and north to south within each OSDF cell. Maximum compacted lift thicknesses for soil, soil-like-materials, and other impacted materials shall be 1.0 ft. (0.3 m), except as provided in Section 8.0 of this IMP Plan. Each lift of topmost select impacted material shall be controlled to line and grade such that cell perimeter contours are within 0.2 ft. (60 mm) of the design grade for the bottom of the contouring layer.

Figure 6-1 illustrates the sequencing of impacted material placement and slope development within the first OSDF cell, looking west to east. Select impacted material layers on the cell base and sideslopes shall be advanced at least 2 ft. (0.6 m) ahead of general impacted material layers. Similarly, Figure 6-2 illustrates the sequencing of impacted material placement and slope development in subsequent cells.

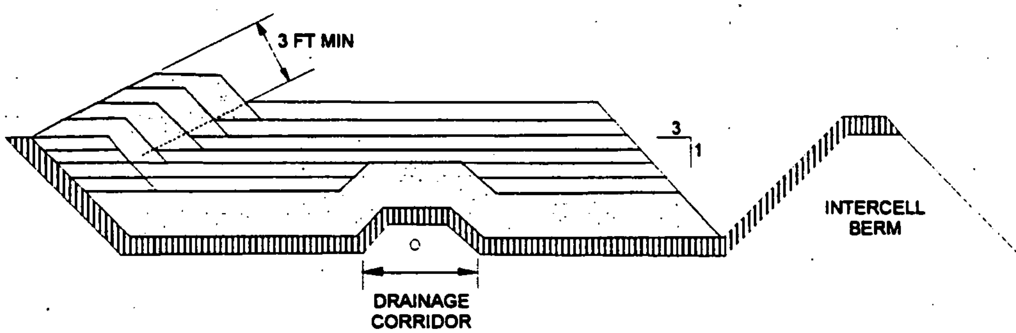
1
2
3

IMPACTED MATERIAL PLACEMENT SEQUENCE - CELL1

(1)



(2)



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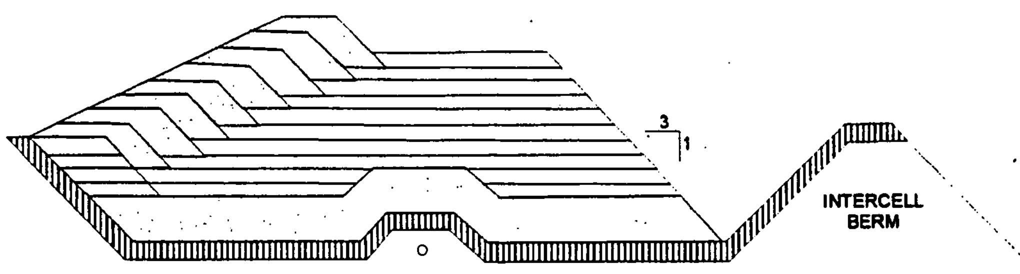
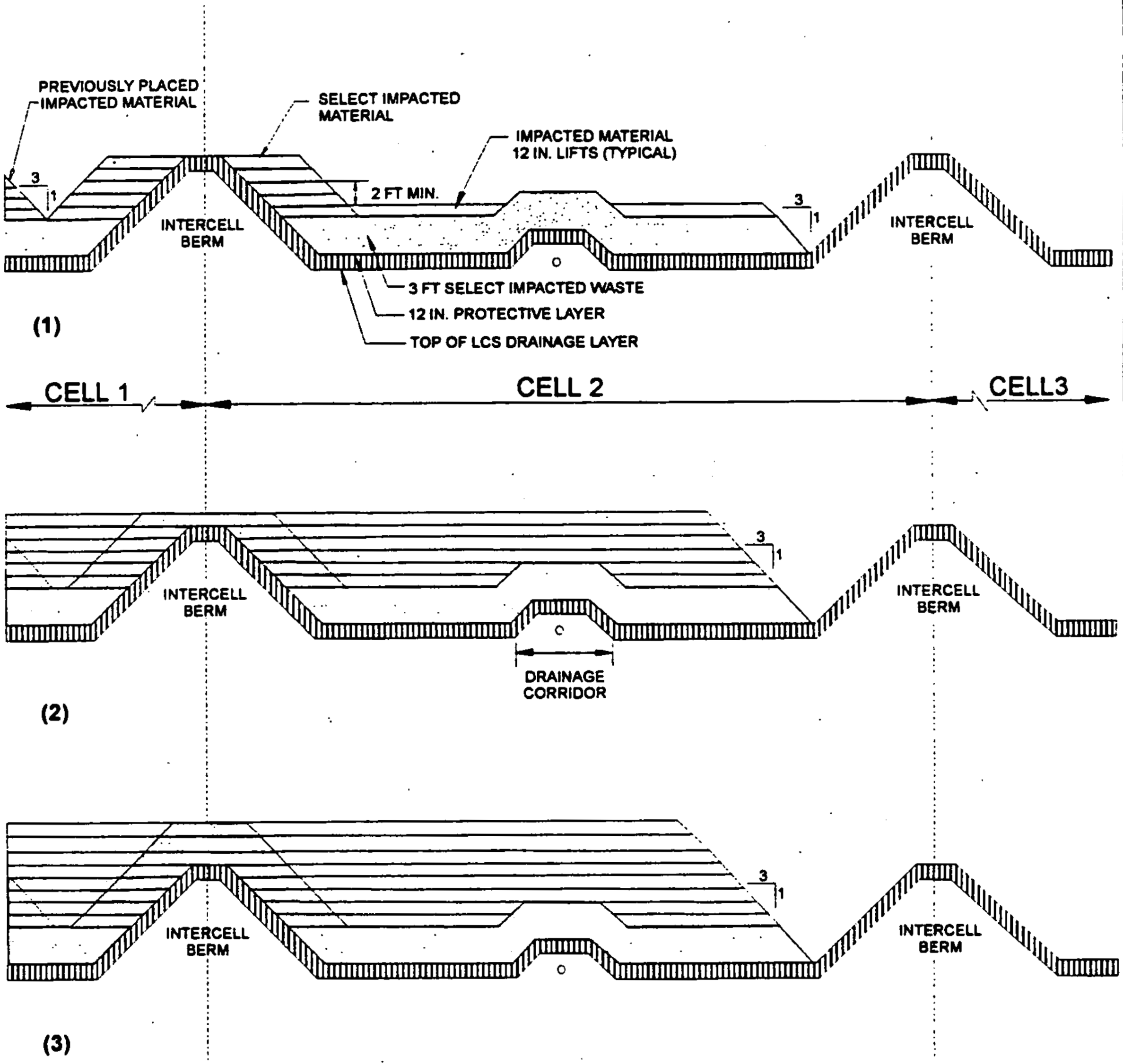


NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS ATLANTA, GEORGIA	FIGURE NO.	6-1
	PROJECT NO.	GQ0166-06
	DOCUMENT NO.	F9620002.CDH
	FILE NO.	FIG-6-1.CDR

1
2
3

IMPACTED MATERIAL PLACEMENT SEQUENCE - INTERIOR CELLS



NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	6-2
PROJECT NO.	GQ0166-06
DOCUMENT NO.	F9620002.CDH
FILE NO.	FIG-6-1.CDR

000037

6.8 Compaction

Each lift of Category 1 impacted material placed in the OSDF shall be compacted by the Subcontractor to the minimum criteria given in Sections 7.0 and 8.0 of this IMP Plan. Monitoring and testing activities are described in Appendix A of this IMP Plan.

6.9 Daily Surface Conditions and Drainage

On a daily basis, the Subcontractor shall maintain the impacted material surface in active OSDF cells to limit fugitive emissions and control and detain impacted runoff. The Subcontractor shall establish stormwater runoff routing in each active cell to convey runoff to the impacted runoff catchment area within the cell. The Subcontractor shall use smooth rolling to seal the surface, silt fences, and other means to limit impacted material erosion. At the end of each working day, the uppermost layer of impacted material shall be sloped at a minimum grade of 2 percent to the south. The southern impacted material face shall be constructed to a slope not steeper than 3H:1V (horizontal:vertical). The Subcontractor shall perform temporary erosion control requirements in accordance with the *OSDF SWMEC Plan*.

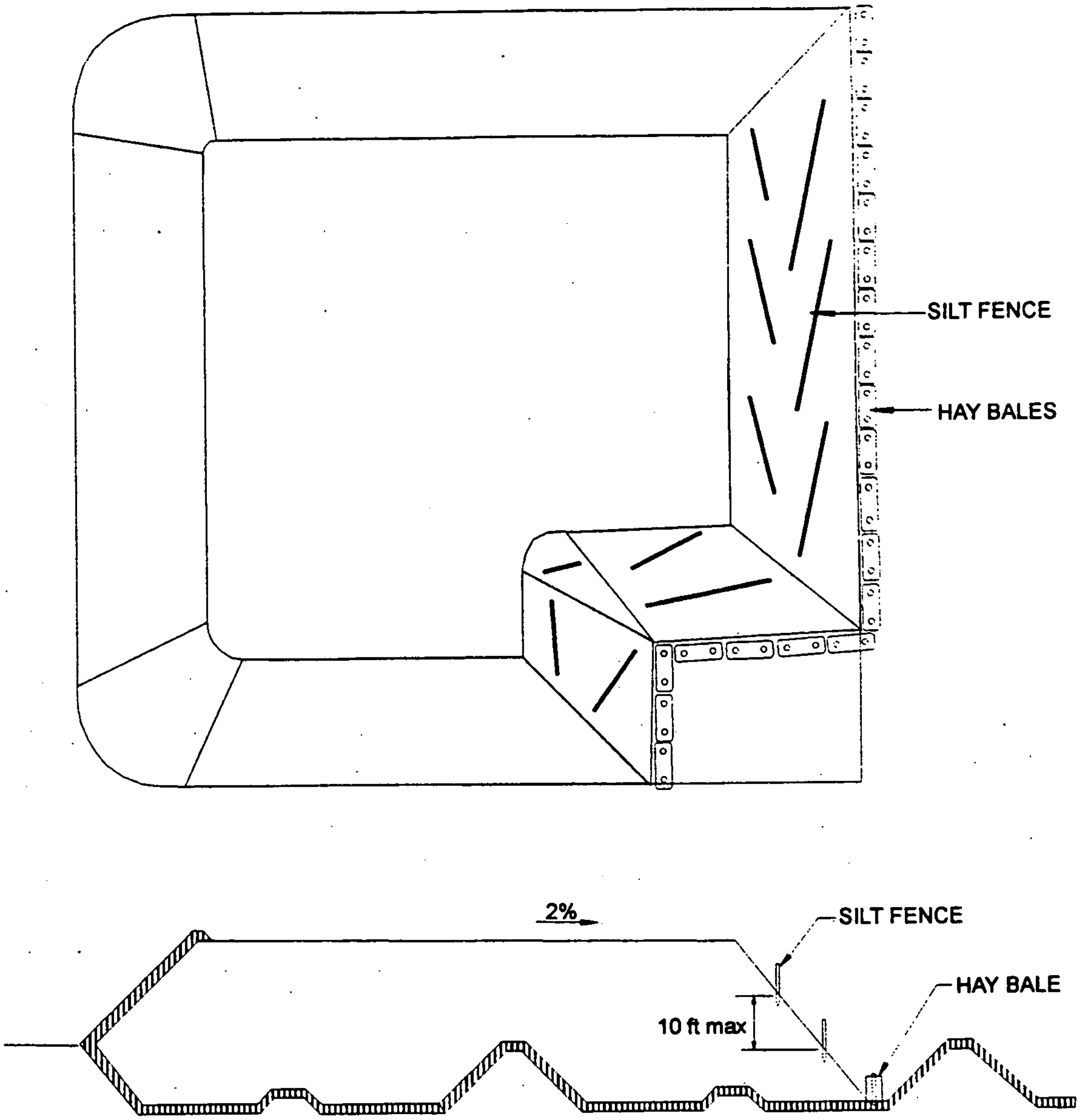
At the end of each working day, the Subcontractor shall prepare exposed impacted material surfaces in a manner that satisfactorily controls the generation of fugitive emissions. Preparation may include smooth rolling to seal the surface, application of water, application of crusting agents, or covering with geosynthetics. Fugitive emission control actions shall be sufficient to achieve compliance with the best available technology (BAT) determination for remedial construction activities on the FEMP site. At all times, the Subcontractor shall be prepared to implement the measures mentioned in this paragraph to reduce fugitive emissions based on the Subcontractor's approved fugitive emissions plan or as directed by the CM.

The final daily lift on areas of active impacted material placement shall consist of a 12 in. (300 mm) thick soil (Category 1 material) layer spread and compacted as described in Section 7.0 for Category 1 material placement. The final compaction pass of this layer shall be made using a smooth-drum roller to seal the surface against excessive infiltration and to control fugitive emissions. Smooth-rolled surfaces shall be disked, tracked, or otherwise broken up prior to placement of subsequent lifts.

Impacted material slopes shall be protected from excessive material erosion through the use of silt fences spaced at a maximum vertical spacing of 10 ft. (3 m) as shown in Figure 6-3. The base of the slope of impacted material, along the perimeter of the impacted runoff catchment area in the cell shall be lined with straw bales to limit the washing of fines into the cell impacted runoff detention area. The impacted runoff catchment area at the southwest corner of each cell has been sized to provide adequate capacity for the detention of the impacted runoff from the 25-year, 24-hour storm event, with 6 in. (150 mm) of freeboard. The catchment area in a current active cell shall be fully maintained until the next active cell becomes operational and the Subcontractor has routed all impacted runoff from the current active cell such that impacted runoff from the 25-year, 24-hour storm event will always be contained within the cells.

Runoff in the impacted runoff catchment area may be pumped into the FEMP former production area stormwater management system or be allowed to percolate through the granular protection layer into the underlying cell leachate collection system. Requirements for maintaining unimpeded infiltration from the impacted runoff catchment area into the leachate collection system are given in the *OSDF Systems Plan*.

IMPACTED MATERIAL
EROSION PROTECTION AND SEDIMENT CONTROL



NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	6-3
PROJECT NO.	GQ0166-06
DOCUMENT NO.	F9620002.CDH
FILE NO.	FIG-6-3.CDR

1

000039

7.0 SOILS AND SOIL-LIKE MATERIAL PLACEMENT

7.1 General

Approximately 85 percent of the impacted material volume to be placed in the OSDF will be Category 1 material (soil and soil-like). Category 1 material may be further divided into: (i) protective and contouring layer soils; (ii) select impacted material layer soils; and (iii) general soil and soil-like material. The placement of this material is expected to be accomplished using similar methods for spreading, grading, and compaction associated with earthwork for OSDF construction. This section of the IMP Plan addresses those activities associated with the placement and compaction of these soils and soil-like Category 1 materials within the OSDF.

7.2 Protective and Contouring Layers

7.2.1 Placement Procedures

As indicated in Section 3.2 of this IMP Plan, the protective and contouring layers shall consist of on-site impacted till or flyash having a maximum particle size not exceeding 3 in. (75 mm) (ASTM C 136). The protective and contouring layers shall also meet the requirements of the construction specifications. Topsoil shall not be used for either the protective or contouring layers.

The protective layer shall be placed in a 12 to 15 in. (300 to 380 mm) thick loose lift. The contouring layer shall be placed in two loose lifts, each between 6 to 8 in. (150 to 200 mm) thick.

7.2.2 Compaction Procedures

To protect the underlying liner system from construction-induced damage, the protective layer shall not be compacted with conventional compaction equipment but rather shall be tracked with a medium-sized bulldozer such as a Caterpillar D-5 (or lighter). The protective layer shall be constructed in conformance with the construction specifications.

The contouring layer shall be compacted to at least 95 percent of the standard Proctor dry density (ASTM D 698). A standard Proctor maximum dry density and optimum moisture content will be established by the CQC Consultant for Category 1 impacted material used in the contouring layer. These materials types will be composited prior to establishing these parameters. These parameters will be obtained by the CQC Consultant in an on-site geotechnical laboratory established for OSDF construction. Each lift of the contouring layer shall be compacted by multiple passes of a self-propelled static pad-foot compactor (*i.e.*, a Caterpillar 815C, or equivalent). It is anticipated that the required compaction moisture content will be within ± 3 percentage points of the material's optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction. The contouring layer shall be constructed in conformance with the construction specifications.

7.3 Select Impacted Material Layers

7.3.1 Placement Procedures

As indicated in Section 3.2 of this IMP Plan, select impacted material shall have a maximum particle size not exceeding 6 in. (150 mm) (ASTM C 136); for material other than impacted till, at least 80 percent of the material shall be finer than a 1 in. (25 mm) particle size. Impacted topsoil may be included in the select impacted material layer but it should not be placed in quantities that deleteriously affect compaction.

The select impacted material layer at the base of the landfill shall be placed in 12 to 15 in. (300 to 380 mm) thick loose lifts and compacted to a minimum total thickness of 3 ft. (0.9 m) (*i.e.*, three lifts of roughly equal thickness). The thickness of select impacted material over the protective layer may be decreased to 2 ft. (0.6 m) if the first lift to be placed over the select impacted material is either Category 1 or Category 2 impacted materials. The select impacted material layer below the final cover system shall be placed in a similar manner to a minimum total thickness of 3 ft. (0.9 m) measured perpendicular to the exterior slope (see Figure 6-1).

7.3.2 Compaction Procedures

A standard Proctor (ASTM D 698) maximum dry density and optimum moisture content will be established for impacted material used in the select impacted material layers. These material types will be composited prior to establishing these parameters. These parameters will be obtained by the CQC Consultant in an on-site geotechnical laboratory established for OSDF construction. Each lift of select impacted material shall be compacted to 85 percent of the standard Proctor maximum dry density if adjacent to the protective layer and to 90 percent of the standard Proctor maximum dry density if adjacent to the contouring layer. It is anticipated that the compaction moisture content will be within ±3 percentage points of the optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction.

7.4 General Soil and Soil-Like Material

7.4.1 Placement Procedures

Category 1 (soil and soil-like) material shall be placed in 12 to 15 in. (300 to 380 mm) thick loose lifts and then compacted as indicated below. Prior to placement of a new lift of Category 1 material, the previous lift shall be disked or tracked to leave the surface in a rough condition. The purpose of this preparation is to promote adhesion of the previous and new lifts and to mitigate preferential seepage pathways forming between adjacent lifts.

7.4.2 Compaction Procedures

Category 1 (soil and soil-like) material shall be compacted to at least 85 percent compaction based on the standard Proctor compaction test, with a running average of at least 90 percent based on the previous 10 samples. The CQC Consultant will establish the standard Proctor maximum dry density (ASTM D 698) and optimum moisture content for Category 1 material requiring compaction. These materials will be composited prior to establishing these parameters. These parameters will be obtained by the CQC Consultant in an on-site geotechnical laboratory established for OSDF construction. It is anticipated that the compaction moisture content of the Category 1 material will be within ±3 percentage points of the material's optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction. These requirements will take into account the workability of the material, the required shear strength to obtain adequate levels of OSDF stability, moisture contents needed to achieve dust and other fugitive emission control, and material trafficability.

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8.0 SPECIAL PLACEMENT REQUIREMENTS

8.1 Introduction

This IMP Plan requires special procedures for the placement of the non-soil-like materials (Categories 2 through 5). The non-soil-like materials consist primarily of impacted materials from the Solid Waste Landfill, the Lime Sludge Ponds, and impacted debris resulting from demolition of structures within the FEMP former production area. The impacted debris consists primarily of building superstructure (*i.e.*, steel, masonry, transite, and other finish components), concrete floor slabs, and building substructure (*i.e.*, concrete footings, pads, and other components).

8.2 Location Recording and Surveying

The Subcontractor shall identify the locations of placement of each zone or horizon of Categories 2 through 5 impacted material as it is placed in the OSDF. For each zone or horizon or other placement unit, the Subcontractor shall establish the horizontal location within 100 ft. (30 m) gridlines and the vertical location by lift. The Subcontractor shall survey the surface of impacted material compacted in place on a 100 ft. by 100 ft. (30 m by 30 m) grid after each week's placement activities. This survey will locate the grid corners to facilitate testing and record keeping. The coordinates used for this survey shall be with respect to the permanent coordinate system established for the OSDF. Where appropriate, sketches of disposal of Category 3 through 5 materials should be provided to show the general orientation and layout of individual and special items.

The Subcontractor shall maintain the grid markers around the perimeter of the cell(s) receiving impacted material. These grid markers are to be placed to a 1 ft. horizontal tolerance.

8.3 Category 2 Material *(En Masse* Placement)

8.3.1 Placement Procedures

Materials conforming to the Category 2 (*en masse* placement) definition shall be placed in the OSDF in loose lifts not exceeding 21 in. (530 mm) in thickness. Prior to placement of a lift of Category 2 material, the placement unit shall be designated such that the unit can be isolated horizontally on all sides with a minimum of 10 ft. (3 m) of Category 1 material. Category 2 material shall then be placed within the designated placement unit to a loose thickness of not more than 21 in. (530 mm). Initial compaction shall be accomplished as the material is spread by tracking with a bulldozer of a minimum total weight of 50,000 lbs (220kN) producing a ground pressure of at least 10 psi (70kPa). After spreading and initial compaction, Category 1 material (of a granular nature when available) shall be spread over the Category 2 material to bring the layer thickness to approximately 24 in. (610 mm). Prior to placement of a second lift of Category 2 material, Category 1 material shall be constructed at the perimeter of Category 2 material to the height of the Category 2 material and to a width of approximately 10 ft (3 m).

As Category 2 material is expected to be less compressible than the majority of the materials contained in the OSDF, the material should be spread laterally prior to placing the material vertically above other Category 2 material. However, as it is also expected to be more permeable than other OSDF material, Category 2 material shall not be spread laterally more than 100 ft. (30 m). In all cases, Category 2 material is to be surrounded in the horizontal directions by at least 10 ft. (3 m) of less permeable Category 1 material. This will reduce the potential for significant lateral migration of leachate. Not more than one lift of Category 2 material shall be placed on top of another lift of Category 2 material without a minimum 4 ft. (1.2 m) thick intervening horizon of Category 1 material.

The Subcontractor should mix Category 1 material as much as practicable with the Category 2 material during excavation and placement activities. The objective of this mixing is to fill voids within the Category 2 material, increase the density of the material placed in the OSDF, and aid in the homogenizing of building rubble, demolition debris, and soils.

8.3.2 Compaction Procedures

After each lift of Category 2 material is placed, the material shall be compacted by four passes of a self-propelled, static pad-foot compactor (*e.g.*, Caterpillar 815C, or equivalent). Soil (Category 1 material) spread on top of the Category 2 material shall be compacted to at least 90 percent of the standard Proctor dry density determined as described in Section 7.4.2 of this IMP Plan. It is anticipated that the soil compaction moisture content will be within ± 3 percentage points of the material's optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction. These requirements will take into account the workability of the soil, the required soil shear strength to obtain adequate levels of OSDF stability, moisture contents needed to achieve dust and other fugitive emission control, and material trafficability. After compacting the Category 1 material over the Category 2 material, the Category 1 material shall be proof rolled. Soft spots indicated by tire ruts more than 2 in. (50 mm) in depth or visible deflection under the moving proof rolling equipment shall be stabilized through additional passes of the compactor. The proof rolling equipment shall have a minimum gross vehicle weight of 20 tons (180 kN) and exert a ground pressure of at least 65 psi (450 kPa). Any soft spot that cannot be stabilized with further compactive effort shall be cause for additional treatment to the satisfaction of the CM. This treatment shall consist of removal, replacement, and recompaction of the soil material, and, if needed, infilling soft spots/areas in the Category 2 material with grout or other material approved by the CM.

8.4 Category 3 Items (Individual Items)

8.4.1 Placement Procedures

Items not more than 4 ft. (1.2 m) in maximum cross-sectional dimension and of regular geometry can be placed as individual members or packages in the OSDF. As much as possible, groups of individual members or packages shall be similarly and regularly sized to enable their placement in the OSDF in regular patterns. Figure 8-1 illustrates the placement of several bundles of packaged transite panels. Spacing requirements for Category 3 materials are as follows: (i) 8 ft (2.4 m) for all materials except structural steel beams/columns/pipe sections, etc.; (ii) 2 ft (0.6 m) for structural steel members with maximum cross-sectional dimension greater than 9 in (225 mm); (iii) structural steel members with maximum cross-sectional dimension less than 9 in (225 mm) shall have a minimum spacing of 3 in. (75 mm). Larger spacing may be necessary to achieve effective compaction of Category 1 materials as described below. Deformed structural members shall be placed such that they lay flat and the foregoing minimum spacing requirements are satisfied.

Items having voids with a volume larger than 1 ft^3 (0.03 m^3) shall be filled with a quick-set grout, or flowable cohesionless material approved by the CM. If a grout is used in this manner, it shall be allowed to set for a minimum of 4 hours prior to the commencement of placement of fill around the item.

Prior to placement of the Category 3 items, the surface of the in-place Category 1 impacted material shall be prepared by rolling with a smooth-drum roller in the area of item placement. The Category 3 items or packages shall be placed on the surface in a regular pattern with an adequate spacing between individual members or packages to allow Category 1 material placement and compaction with available equipment. Members should be placed with a flat side, if one exists, against the underlying Category 1 material. Channel or pipe half-sections, or other types of members with an open side and closed side, shall be placed with the open side facing up so that it could be fully infilled. The space between each member or package shall be filled with Category 1 material placed in maximum 12 in. (300 mm) thick compacted lifts. A final maximum 12 in. (300 mm) thick compacted lift of Category 1 material shall be placed over each grouping of Category 3 items.

As the Category 3 materials are expected to be less compressible than the majority of the impacted materials placed in the OSDF, the Category 3 items should be placed toward the center of the a cell and not in the same horizon with more compressible materials (*i.e.*, Category 4 materials, and sludges and double-bagged asbestos of Category 5 materials). Horizons of Category 3 materials shall be separated by at least a 4 ft. (1.2 m) thick intervening horizon of Category 1 material.

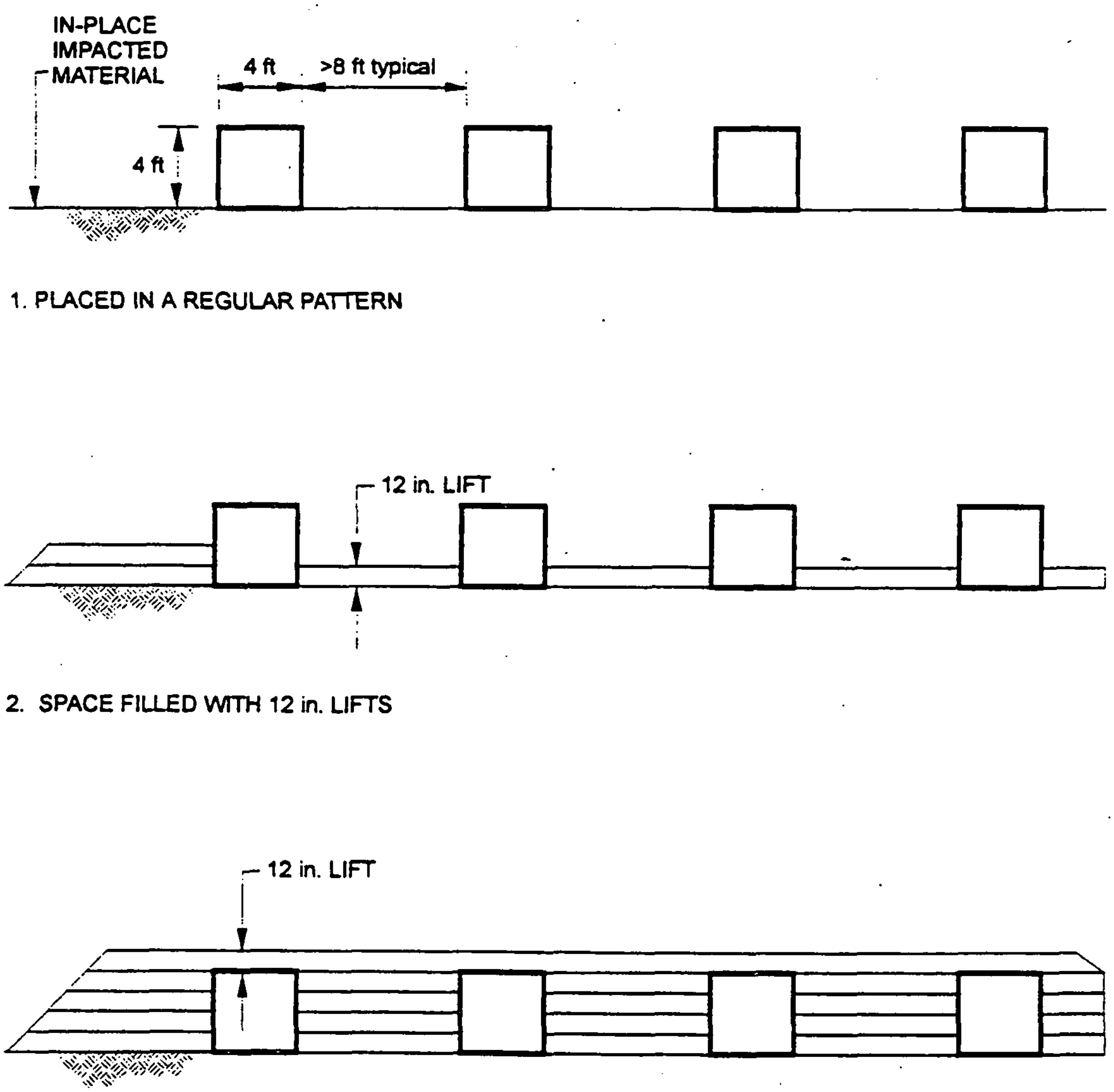
8.4.2 Compaction Procedures

Each lift of soil (Category 1 material) between and above the Category 3 items shall be compacted using equipment capable of achieving compaction to at least 90 percent of the standard Proctor dry density, determined as described in Section 7.4.2 of this IMP Plan. It is anticipated that the compaction moisture content for this Category 1 material will be within ± 3 percentage points of the material's optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction. These requirements will take into account the workability of the soil, the required soil shear strength to obtain adequate levels of OSDF stability, moisture contents needed to achieve dust and other fugitive emission control, and material trafficability.

For structural steel members with maximum cross-sectional dimension less than 9 in. (225 mm) and placed 3 in. (75 mm) apart, the members shall be infilled and covered with a cohesionless sand or other suitable material evaluated by the CM as capable of completely infilling the space between members. The material shall be compacted so that the structural members are completed infilled. Compaction shall consist of at least three full coverage passes of a driven or walk-behind smooth drum vibratory roller. The CM may specify additional compaction requirements if needed to achieve complete infilling.

A final 12-in. (300-mm) thick compacted lift of soil (Category 1 material) shall be placed above the Category 3 material. This final compacted lift shall be proof-rolled using equipment with a minimum gross vehicle weight of 20 tons (180 kN) and exert a ground pressure of at least 65 psi (450 kPa). Soft spots indicated by tire ruts more than 2 in. (50 mm) in depth or visible deflection under the moving proof rolling equipment shall be stabilized through additional passes of the compactor. Any soft spot that cannot be stabilized with further compactive effort shall be cause for additional treatment to the satisfaction of the CM.

CATEGORY 3 MATERIAL PLACEMENT SEQUENCE



1. PLACED IN A REGULAR PATTERN

2. SPACE FILLED WITH 12 in. LIFTS

3. FINAL 12 in. LIFT PLACED ABOVE GROUPS

NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS ATLANTA, GEORGIA	FIGURE NO.	8-1
	PROJECT NO.	GQ0166-06
	DOCUMENT NO.	F9620002.CDH
	FILE NO.	FIG-6-3.CDR

This treatment shall consist of removal, replacement, and recompaction of the soil (Category 1 material), and, if needed, infilling soft spots/areas around the Category 3 material with grout or other material approved by the CM.

8.5 Category 4 Materials (Highly Compressible)

8.5.1 Placement Procedures

Soil (Category 1 material) berms which are a minimum of 12 in. (300 mm) high shall be placed around Category 4 material. Category 4 material shall be placed adjacent to the berms to a loose thickness of approximately 18 in. (450 mm). Initial compaction shall be accomplished as the material is spread by tracking with a bulldozer of a minimum total weight of 50,000 lbs (220 kN) producing a ground pressure of at least 10 psi (70 kPa). Prior to placement of the succeeding lifts of Category 4 material, a minimum 12 in. (300 mm) thick loose lift of soil (Category 1 material) shall be placed over the Category 4 material and compacted as indicated below. Compaction of the second lift of Category 4 materials shall be identical to the first lift. Not more than two lifts of Category 4 material shall be placed in a horizon. Category 4 horizons shall not be in the same vertical plane as previously placed Category 4 horizons.

8.5.2 Compaction Procedures

After spreading and initial compaction, the Category 4 material shall be compacted by minimum of four passes of a self-propelled, static pad-foot compactor having a nominal weight of at least 45,000 pounds (*e.g.*, Caterpillar 815C, or equivalent). After each sequence of Category 4 material compaction and covering soil (Category 1 material) placement, the cover soil shall be compacted as required for the soil cover of Category 2 material. The soil cover shall then be proof-rolled. The proof rolling equipment shall have a minimum gross vehicle weight of 20 tons (180 kN) and exert a ground pressure of at least 65 psi (450 kPa). Soft spots indicated by tire ruts more than 2 in. (50 mm) in depth or visible deflection under the moving proof rolling equipment shall be stabilized through additional passes of the compactor. Any soft spot that cannot be stabilized with further compactive effort shall be cause for additional treatment to the satisfaction of the CM. This treatment shall consist of removal, replacement, and recompaction of the soil (Category 1 material), and, if needed, infilling soft spots/areas in the Category 4 material with grout or other material approved by the CM.

8.6 Category 5 Materials (Special Handling, Placement and Compaction)

8.6.1 Introduction

Category 5 materials are materials that require special handling, placement and compaction procedures. These materials will be classified and designated in accordance with the approved RODs and the WAC. This section of the IMP Plan establishes procedures for disposal of impacted material that require special handling.

Materials either nominally larger than the physical criteria for the OSDF as identified in Section 4.3 Physical Criteria of this IMP Plan, or not reasonably anticipated by the currently identified categories in this IMP Plan, will require specialized placement plans to be developed on an as needed basis. Such plans would be developed by the OSDF project team with the assistance of the resident engineer as appropriate, and submitted to the regulatory agencies for review and approval prior to utilization. It is anticipated that such plans would be submitted concurrent with remedial action planning documents which identify items for special handling, or following the discovery of unexpected materials outside the current categorizations. Once approved, these specialized placement plans either would become addenda to this IMP Plan, or the appropriate section(s) of this IMP Plan would be revised accordingly.

8.6.2 General

Impacted materials suitable for placement in the OSDF that require special handling include:

- highly-compressible impacted materials not suitable for lateral spreading as a Category 4 material (*e.g.*, double-bagged asbestos);
- piping insulated with asbestos containing material (ACM); and
- sludges.

Placement and compaction procedures for these types of impacted materials are presented below.

8.6.3 Highly Compressible Materials

Placement

The volume of highly compressible material, such as double-bagged asbestos, requiring OSDF disposal is very limited. The primary criterion regarding the placement of asbestos is that the material be placed and compacted in a manner protective of the health of OSDF personnel and the public. A secondary criterion is to prevent significant differential settlement of the OSDF final cover system resulting from compression of this material.

Prior to placement of any highly compressible material in the OSDF, a trench shall be dug into previously placed and compacted Category 1 material. Material excavated from this trench shall be stockpiled at least 6 ft. (1.8 m) away from the trench opening. No trenches shall be dug into layers containing Category 2 through 5 material, nor through the protective, contouring, or select impacted material layers. Trenches shall be of uniform width (between 2.0 and 3.0 ft. (0.6 and 0.9 m) wide) and of a uniform depth (between 3.0 and 4.0 ft. (0.9 and 1.2 m) deep). The final sizing of the trench shall depend on the nature and size of the material to be disposed. Highly compressible material, such as double-bagged asbestos, shall be deposited in the lower half of the trench.

Compaction

An initial soil (Category 1 material) cover between 12 and 18 in. (300 and 450 mm) loose thickness shall be placed on top of the highly-compressible material in the trench. The initial soil cover layer shall be compacted with a minimum of four passes of a portable flat-plate or miniature roller compactor. Intermediate 6- to 12-in. (0.15- to 0.3-m) thick loose soil lifts shall be placed in the trench and compacted to at least

90 percent of the standard Proctor dry density determined as described in Section 7.4.2 of this IMP Plan. A final trench soil lift shall be placed to a compacted height (at least 90 percent of the Standard Proctor dry density) and at least 2 in. (50 mm) above the trench shoulders. The sequencing of material placement is illustrated in Figure 8-2.

8.6.4 Piping Containing ACM Insulation

Placement

The disposal of ACM-insulated piping in the OSDF shall be performed in a manner protective of the health of OSDF personnel and the public. These materials must be segregated from other demolition debris at the source and delivered to the OSDF in a condition suitable for placement in an excavation dug into previously placed and compacted Category 1 material. The size and shape of the excavation will be based on the predominant dimension and condition of the piping. If the piping comes to the OSDF in relatively straight lengths, the pipes shall be placed in trenches similar to those required for double bagged asbestos. If the piping comes to the OSDF in random shapes, bends, or curvatures, the pipes shall be placed in a rectangular excavation sized to accommodate the pipe but not greater than 20 ft. (6 m) square and 4 ft. (1.2 m) deep. The ACM-insulated piping shall be placed in the lower half of the excavation.

Compaction

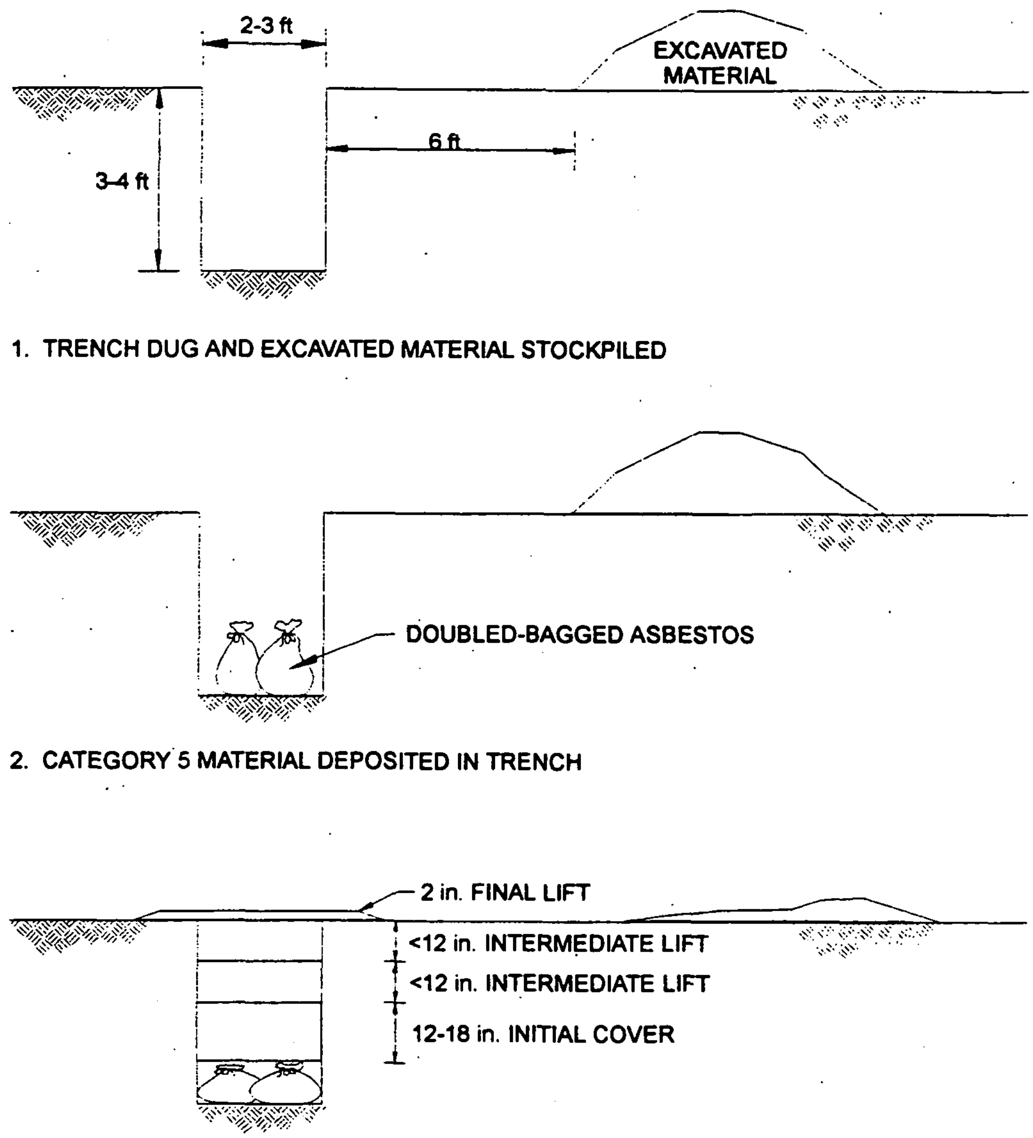
An initial soil (Category 1 material) loose lift between 12 and 18 in. (300 and 450 mm) thick shall be placed on top of the ACM-insulated piping in the excavation. The initial soil cover layer shall be compacted with a minimum of four passes of a portable flat-plate or miniature roller compactor or a pad-foot compactor such as the Caterpillar 815C as appropriate. Intermediate 6 to 12 in. (150 to 300 mm) loose soil lifts shall then be placed in the excavation and compacted to at least 90 percent of the standard Proctor dry density, determined as described in Section 7.4.2 of this IMP Plan. A final excavation soil lift shall be placed to a compacted height at least 2 in. (50 mm). above the excavation shoulders.

8.6.5 Sludges

Placement

The placement, spreading, and compaction of the sludge material from the Lime Sludge Ponds or the AWWT will depend on the water content of the sludge when delivered to the OSDF. Sludge materials from the Lime Sludge Ponds should be mixed with soils from the berms of the ponds as much as practicable during excavation or drying until excessive moisture is removed. The objective of this activity is to decrease the moisture content of the sludges and thereby improve their handling and subsequent compaction characteristics. The CM may specify additional source(s) of materials for mixing with the sludges to achieve the required handling and placement characteristics. The following procedure assumes the sludge can be placed and compacted with conventional construction equipment, either by mixing as above in the case of the Lime Sludge Ponds, or by proper preconditioning (dewatering or drying) in the case of the AWWT sludges. In no case shall mixing and precondivity be performed in the OSDF active cell.

CATEGORY 5 MATERIAL PLACEMENT SEQUENCE



NOTE: THIS FIGURE FOR ILLUSTRATION ONLY. SUBCONTRACTOR SHALL PLACE IMPACTED MATERIAL LAYERS TO THE LIMITS SHOWN ON CONSTRUCTION DRAWINGS.

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	8-2
PROJECT NO.	GQ0166-06
DOCUMENT NO.	F9620002.CDH
FILE NO.	FIG-6-3.CDR

Prior to placement of the first lift of sludge material, the surface of in-place impacted material shall be prepared with starter berms at least 12 in. (300 mm) high. Sludge materials shall be placed within the starter berms to a maximum loose thickness of 12 in. (300 mm.).

Compaction

Initial compaction shall be accomplished as the material is spread. After spreading and initial compaction, the material shall be compacted by a minimum of four passes of a bulldozer of a minimum total weight of 50,000 lb (220 kN) producing a ground pressure of at least 10 psi (70 kPa). Prior to placement of the second and succeeding lifts of sludge materials, a 12 in. (300 mm) thick lift of soil (Category 1 material) shall be placed above the sludge lift and compacted to at least 85 percent of the standard Proctor dry density for the soil. After placement of the soil lift, another starter berm shall be constructed as with the first lift of sludge material. Compaction of all succeeding lifts of sludge materials shall be identical to the first lift. Not more than two lifts of sludge material shall be placed in a horizon without a minimum 4 ft. (1.2 m) thick intervening horizon of Category 1 material.

After each sequence of sludge and covering soil placement, the cover soil shall be proof-rolled. The proof rolling equipment shall have a minimum gross vehicle weight of 20 tons (180 kN) and exert a ground pressure of at least 65 psi (450 kPa). Soft spots indicated by tire ruts more than 2 in. (50 mm) in depth or visible deflection under the moving proof rolling equipment shall be stabilized through additional passes of the compactor. Any soft spot that cannot be stabilized with further compactive effort shall be cause for additional treatment to the satisfaction of the CM. This treatment shall consist of removal, replacement, and recompaction of the soil material, and, if needed, infilling soft spots/areas in the Category 5 material with grout or other material approved by the CM.

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9.0 IMPACTED RUNOFF AND FUGITIVE EMISSIONS CONTROL

9.1 General

This section of the IMP Plan provides the requirements for impacted runoff and fugitive emissions control within the OSDF battery limit as it relates to impacted material placement. Within the OSDF battery limit, all impacted material placement activities shall be confined to within the OSDF cell lined area. Activities related to the collection, handling, staging, loading, and transportation of impacted materials outside the OSDF battery limit are addressed as part of other work plans prepared as a part of the integrated FEMP remediation.

9.2 Runoff Control

9.2.1 OSDF Cell

Impacted runoff will be generated whenever precipitation comes in contact with impacted materials. Impacted runoff generated within the OSDF cell shall be managed as stated in Section 6.9 of this plan and in general conformance with the requirements of the *OSDF SWMEC Plan*. Impacted runoff shall be conveyed using temporary surface-water management structures to the impacted-runoff catchment area in the southwest corner of the most southerly active cell. As previously described in this plan, layers of impacted material shall be placed from north to south and east to west within each cell. As these layers are placed, the impacted-runoff catchment area shall be preserved until a more southerly cell is made active.

9.2.2 Impacted Material Haul Road

Impacted runoff from an impacted material haul road shall be contained within the boundaries of the road until it enters a sump at the western most end of the road. From this sump, the impacted runoff shall be routed to the storm drainage control of the FEMP former production area, or to other on-site wastewater collection/conveyance points acceptable to the CM.

9.3 Fugitive Emissions Control

9.3.1 General

Fugitive emissions may result from impacted material handling and hauling activities. Material handling covers such activities as excavation, dumping, spreading, compacting, and short-term storage. These activities may generate fugitive emissions in the form of particulate matter released to the air (*i.e.*, dust). These activities will comply with the BAT determination for remedial construction activities on the FEMP site that was developed to control fugitive emissions (see Appendix B). The appropriate records shall be kept when visible emissions observations are performed in accordance with Appendix A of 40 CFR Part 60, and the FEMP procedure for fugitive dust control requirements, which is currently being developed.

The Subcontractor shall also control fugitive emissions while hauling impacted materials to the OSDF. If visible emissions are in excess of the limit discussed in the BAT determination for remedial construction activities on the FEMP site, the CM will direct the Subcontractor to provide a corrective action plan.

As appropriate, the Subcontractor shall use one or more of the following for the control of fugitive emissions from the OSDF:

- water sprays;
- crusting agents;
- operational controls; and
- wind screens.

Each of the above controls is briefly discussed in the following subsections.

9.3.2 Water Sprays

The Subcontractor shall use water distributors and spray trucks to control fugitive dust emissions in active OSDF cells and along impacted-material haul roads within the battery limit. The frequency of water application should be weather dependent and be adjusted based on the appearance of visible dust as described in the BAT determination for remedial construction activities on the FEMP site.

9.3.3 Crusting Agents

The Subcontractor shall consider the use of crusting agents or other suitable dust suppression chemicals whenever water is not effective or when a particular area will not be disturbed for long enough to justify the additional cost. The Subcontractor shall demonstrate to the CM the compatibility of any crusting agent or other suitable dust suppression chemical with components of the OSDF liner system prior to use.

9.3.4 Operational Controls

The Subcontractor may use operational controls to limit fugitive emissions. Limiting placement of impacted material to days when the wind is calm, and limiting the speed of hauling equipment, are examples of operational controls. The Subcontractor shall work closely with the CM in the development and implementation of other beneficial operational controls to be implemented both on a daily and overall basis.

9.3.5 Wind Screens

The OSDF will be elevated above surrounding lands during its operational life. Increased winds at the higher elevation may cause additional fugitive emissions during periods of operation at the higher elevations. Silt fence on impacted material slopes installed for the control of surface erosion caused by precipitation may provide a measure of protection from winds. The Subcontractor shall consider the use of additional wind screens when other methods of fugitive emissions control prove ineffective.

10.0 REQUIRED DOCUMENTATION

10.1 General

This section of the IMP Plan contains information on the documentation required for each truck load of impacted materials to be placed in the OSDF.

10.2 Manifesting System

No impacted material will be accepted at the OSDF without an accompanying impacted material transportation "manifest". The purpose of the "manifest" is to provide a tracking mechanism for impacted material from the remediation project of origin to placement in the OSDF.

Information anticipated to be included on the "manifest" include:

- originating remediation project (*e.g.*, operable unit and project);
- date and time of origination (*e.g.*, loading for debris, excavation for other materials);
- brief visual description of the impacted material in the load;
- classification of the impacted material into one of the five material categories of this IMP Plan;
- signature by originating remediation project representative that the material meets the criteria in Section 4.0 of this IMP Plan;
- Subcontractor (transporter) signature;
- date and time of receipt; and
- CQC Consultant signature.

10.3 Impacted Materials Tracking

To aid in tracking impacted material, each impacted material transportation "manifest" will have a unique serial number and two carbon copies. One carbon copy each will be forwarded to the remediation project from which the impacted material originated and to the OSDF Subcontractor. The original will be retained by the CQC Consultant verifying that the impacted material has been disposed in the OSDF.

10.4 Records Procedures

FDF will be responsible for establishing the procedures and requirements for collection, storage, maintenance, and disposition of all OSDF records. Records shall be protected from damage or deterioration by being placed in lockable, fire-proof filing cabinets and by duplication and/or microfilming. Records shall be filed in accordance with the subject file index and shall be retained for 30 years after closure of the OSDF. Required records shall include, but not be limited to, field logbooks, other data collection forms, equipment calibration records, cost data, drawings, impacted material transportation "manifests", maintenance records, and associated reports.

All original data collected in the field shall be considered a permanent record. This includes all field logbooks, other data forms, and photographs. All of these documents shall be authorized by the signature and date of the originator. Errors shall be corrected by crossing a single line through the error and entering the correct information. Corrections will be initialed and dated by the person making the correction.

11.0 SEASONAL COVER

11.1 Description of System

At the end of each construction season and in any area where impacted material will not be placed for at least 30 days, a seasonal cover will be required over any area that has not received final cover. The seasonal cover will consist of natural or impacted soil with suitable surface protection, surfactants (*e.g.*, commercially-available crusting agents), or geosynthetic erosion control surface matting.

11.2 Seasonal Cover Inspection and Monitoring Activities

The seasonal cover shall be inspected and monitored in accordance with the schedule and activity requirements presented in Table 11-1. The purposes of the inspection and monitoring activities are to: (i) ensure the seasonal cover prevents excessive fugitive emissions and slope erosion; (ii) provide adequate and efficient management of impacted runoff within a cell; and (iii) provide adequate protection of liner systems components from freeze/thaw and mechanical damage.

Inspections of the seasonal cover shall consist of a survey of the seasonally-covered area. The visual inspection shall be conducted by either traversing the cover systems on a 100 ft. (30 m) grid pattern or by using binoculars to inspect areas where surface crusting agents have been applied. Suspect areas shall be delineated on a plan of the site. The inspections shall result in evaluation of the seasonal cover for excessive erosion or gullying. Should such conditions be observed, the Subcontractor shall implement activities to reduce such erosion or gullying, including regrading the eroded area, compacting exposed soil surfaces, rerouting runoff from the area to promote sheet flow, applying additional surface crusting agent, or installing geosynthetic erosion-control surface matting.

The seasonal cover inspections shall also include observation of the area within the active OSDF cell being used for impacted runoff retention. The inspection shall confirm that runoff into the area can infiltrate in an unimpeded manner into the cell leachate collection system (LCS). The inspection shall also confirm that excessive sedimentation is not occurring. Should the depth of sedimentation exceed 6 in. (150 mm) in any portion of this area, the sediment should be excavated and transported to an area of the cell outside of the impacted runoff retention area. Any excavation of sediment within the cell shall be performed with extreme care so as not to damage the underlying liner systems. Should the granular protective layer or geotextile LCS filter in the stormwater retention area of the cell become clogged and impede stormwater percolation into the LCS, the CM may instruct the Subcontractor to replace the granular material, and possibly the geotextile filter as well.

Repairs to a cell stormwater retention area shall not be made unless it is part of a plan reviewed by the CM. Any repair activity involving any component of the liner systems or final cover systems shall be in full conformance with the construction specification for that component.

TABLE 11-1

SEASONAL COVER
INSPECTION AND MONITORING ACTIVITIES

Component	Inspections	Condition	Maintenance
	Seasonal-Closure Period		
Seasonal Clover	Bi-weekly	• unacceptable surface or slope erosion • unacceptable fugitive emissions	• regrade material surfaces; reroute runoff; compacted soil surface, apply crusting agents or geosynthetic erosion control matting • apply surface crushing agent or geosynthetic erosion control matting; install wind screen fencing
Impacted-Runoff Retention Area (in cell)	Bi-weekly	• sediment deposited on top of drainage area • lack of timely percolation of drainage into the LCS	• remove and deposit in outside of drainage area • replace clogged protective layer granular material with new clean material; replace clogged geotextile filter layer
Protection of Liner System	Bi-weekly	• system must be protected against frost and mechanical damage by at least 2 ft Category 1 material	• add soil cover over anchor trench geosynthetics geosynthetics

11.3 Recordkeeping

The Subcontractor shall maintain written records of all monitoring, inspections, and repairs in accordance with recordkeeping and reporting requirements of Section 10.4 of this IMP Plan.

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APPENDIX A

IMPACTED MATERIALS PLACEMENT QUALITY ASSURANCE PLAN

Fernald Environmental Management Project
Fernald, Ohio

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APPENDIX A1

IMPACTED MATERIALS MANIFEST

A.1 INTRODUCTION

A.1.1 Overview

This IMP Quality Assurance (QA) Plan describes the activities which shall be undertaken throughout the construction, placement, and closure of the OSDF to assure the acceptance, filling, and compaction of the impacted materials in the OSDF are in accordance with the procedures established in the *IMP Plan* and *CQA Plan*. This plan contains requirements and procedures specifically applicable to impacted materials after they are brought into the OSDF battery limit.

A.1.2 Plan Scope

This IMP QA Plan establishes the QA/QC procedures and documentation practices to be used to monitor and test impacted materials which are transported, placed, and compacted by the Subcontractor within the OSDF battery limits. The scope of this plan includes:

- CQC Consultant duties related to impacted materials; and
- monitoring, testing, and documentation procedures to be used in assuring impacted material placement is in accordance with the requirements of the *IMP Plan*.

A.1.3 Plan Organization

The remainder of this plan is organized as follows:

- the job descriptions, qualifications, and required training of personnel involved in IMP QA are presented in Section A.2;
- specific monitoring procedures are presented in Section A.3;
- specific compaction testing requirements for each impacted material category are presented in Section A.4;
- requirements for as-placed plans are presented in Section A.5.

Appendix A1 to this IMP QA Plan contains the manifest to be used in tracking impacted material placement in the OSDF.

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A.2 IMP QA PERSONNEL

A.2.1 Staffing Requirements

Monitoring and testing of the placement and compaction of impacted materials at the OSDF shall be the responsibility of the CQC Consultant. The following personnel shall have responsibilities related to the impacted materials placement QC activities at the OSDF:

- CQC Managing Engineer;
- CQC Site Manager; and
- CQC Field Monitors.

A.2.2 CQC Managing Engineer

A.2.2.1 Job Description

The CQC Managing Engineer shall be in overall charge of the QC activities related to impacted material placement. In addition to the duties described in the *CQC Plan*, the CQC Managing Engineer shall also be responsible for monitoring of the impacted materials placement and compaction in the OSDF.

A.2.2.2 Required Job Qualifications

The required qualifications of the CQC Managing Engineer are contained in the *CQA Plan*.

A.2.3 CQC Site Manager

A.2.3.1 Job Description

The CQC Site Manager shall be in direct day-to-day charge of the QC monitoring conducted at the OSDF during impacted materials placement. In addition to the duties described in the *CQA Plan*, the CQC Site Manager shall also be responsible for:

- Monitoring impacted materials suitability for disposition in the OSDF.
- Evaluating the compaction of the impacted materials in the OSDF.
- Supervising the compaction testing of impacted materials in the OSDF.
- Assigning CQC Field Monitors.
- Forwarding required documentation to the CQC Managing Engineer.
- Assuring that CQC Field Monitors attend regular health and safety meetings.

A.2.3.2 Required Job Qualifications

The qualifications of the CQC Site Manager are contained in the *CQA Plan*.

A.2.4 CQC Field Monitors

A.2.4.1 Job Description

CQC Field Monitors shall perform placement monitoring and compaction testing of impacted materials in the OSDF in accordance with this IMP QA Plan. Placement monitoring and compaction testing shall include documentation that the Subcontractor is performing in accordance with the procedures specified in the *IMP Plan*. Monitors shall also classify, as necessary, the impacted materials for the purposes of assigning a compaction method to the impacted materials.

A.2.4.2 Required Job Qualifications

CQC Field Monitors shall have experience in performing QC in earthwork construction, demolition, or solid waste industries or in an equivalent industry.

A.2.5 Training

Training requirements for personnel employed at the FEMP are contained in the Fernald Site Wide Training Plan - PL-3032 [FERMCO, 1995]. Personnel engaged in impacted materials QA/QC activities at the OSDF shall be trained in accordance with this plan.

Each CQC Consultant employee shall have OSHA 40-Hour Hazardous Waste Workers' Health and Safety Training (HAZWOPER) conducted in accordance with 29 CFR 1910.120. Each employee shall also take an 8-hour Hazardous Waste Workers' Health and Safety Training refresher course each year, and no more than 1 year from the date of completion of the 40-hour HAZWOPER training. The CQC Site Manager shall receive 8-hour HAZWOPER Supervisory training.

Each new employee shall receive 3 days of on-the-job training as required by 29 CFR 1910.120. On-the-job training will include, at a minimum, a discussion of site specific health and safety features, a walk-through of the areas in which the new employees will be working with a discussion of possible hazards in the area, a discussion of job duties and potential hazards associated with the duties and a discussion regarding appropriate personal protective equipment (PPE) including minimum requirements for work clothing in accordance with the site specific health and safety plan.

A.3 IMPACTED MATERIALS MONITORING

A.3.1 Required Documentation

Upon entering the OSDF battery limits, the CQC Consultant shall check that the impacted materials are accompanied by a "manifest" and that the hauling unit has been properly identified as to the impacted material category. Impacted material categories are defined in Section 5.2 of the *IMP Plan*. If no material category has been entered onto the manifest, the hauling unit shall be turned around and sent back to its point of origin. The CQC Consultant shall verify that the "manifest" contains all information relating to the impacted material origin as specified by Section 10.2 of the *IMP Plan*. The CQC Consultant shall complete the "manifest" by recording any pertinent notes, comments, or observations about the load. The CQC Consultant shall finally affix a signature to the "manifest" verifying that the load has been delivered in accordance with the *IMP Plan*.

A.3.2 Visual Inspection

The CQC Consultant shall perform a visual review of the impacted materials entering the OSDF. The contents of each hauling unit (truck load or containers) shall be viewed after dumping to assure that the contents match the visual description entered on the "manifest".

A.3.3 Monitoring for Moisture Content

Impacted materials accepted at the OSDF shall be at a moisture content suitable for placement and compaction in accordance with the *IMP Plan*. If the CQC Consultant determines that impacted materials are too wet, the Subcontractor shall dry the material to a condition allowing placement and compaction in accordance with the *IMP Plan*.

A.3.4 Demolition Debris Monitoring

General

The CQC Consultant shall monitor demolition debris delivered to the OSDF. Additional information regarding waste classification and special handling of specific types of demolition debris is presented in the following sections.

Asbestos

Trucks carrying double bagged regulated asbestos containing material must display asbestos warning signs. The Subcontractor shall comply with all regulations relating to the handling and transportation of regulated asbestos containing material.

Broken Concrete

Most concrete demolition debris will fall into Category 2 (*en masse* placement). Loads of concrete containing concrete pieces that cannot be spread into 18 in. (450 mm) loose lifts will be classified as Category 5 materials.

Steel or Transite Sidings

Steel or transite sidings that arrive at the OSDF in neatly packaged stacks not greater than 4 ft. (1.2 m) high will be classified as Category 3 items (individual placement). Loose truck loads of miscellaneous demolition debris containing steel sidings that can be spread in lifts not higher than 18 in. (450 mm) will be classified as Category 2 materials (*enmasse* placement).

Steel Beams

Steel beams which can be spread or placed into a lift no higher than 18 in. (450 mm) will be classified as Category 2 materials (*en masse* placement). Steel beams that cannot be placed in a lift not greater than 18 in. (450 mm) but which can be placed individually such that the highest part of the beam is not more than 4 ft. (1.2 m) above the ground surface will be classified as Category 3 items (individual items).

Wood

Loads of demolition debris consisting primarily of wood and that can be spread in lifts no higher than 18 in. (450 mm) will be classified as Category 4 materials (highly compressible).

Miscellaneous Demolition Debris

Loads of miscellaneous demolition debris (doors, plumbing, wiring, *etc.*) that can be spread in lifts no higher than 18 in. (450 mm.) will be classified as Category 2 materials (*en masse* placement). Miscellaneous demolition debris that can be placed individually such that the highest part of the debris is not more than 4 ft. (1.2 m) above the ground surface will be classified as Category 3 items (individual items).

Tanks

Tanks cannot be placed such that the void space can be filled and Category 1 material placed and compacted around them shall not be placed in the OSDF. Pressurized or pressurizable cylinders which have not been cut in half such that they cannot contain pressurized materials will not be accepted at the OSDF. Tanks acceptable for placement in the OSDF and which are less than 5 ft. (1.5 m) in diameter and 4 ft. (1.2 m) high will be classified as Category 3 items (individual items).

Pipes

Steel pipes which can be spread or placed into a lift no higher than 18 in. (1.5 ft.) will be classified as Category 2 materials (*en masse* placement.) Larger steel pipes than cannot be placed in a lift not greater than 18 in. (450 mm) but which can be placed individually such that the highest part of the pipe is not more than 4 ft. (1.2 m) above the ground surface will be classified as Category 3 items (individual items).

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A.4 IMPACTED MATERIAL PLACEMENT AND COMPACTION

A.4.1 Category 1 Materials (Soils and Soil-Like)

General Monitoring Requirements

Monitoring the placement and compacting of impacted soil and soil-like materials includes the following:

- testing to determine the water content and other physical properties of the impacted soil materials during processing, placement, and compaction;

- monitoring the thickness of lifts as loosely placed and as compacted; and

- monitoring the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.).

Placement and Compaction Quality Control

The standard Proctor test (ADTM D 698) shall be used for the determination of moisture/density relationships on the Category 1 material to be disposed in the OSDF. These material types will be compacted prior to establishing their parameters. The standard Proctor tests will be performed in the on-site geotechnical laboratory established per the *CQA Plan*.

The dry density, moisture content, and loose lift thickness of Category 1 materials shall be measured at a minimum frequency of once per 10,000 ft^2 (930 m^2) *or* once per 100 ft. by 100 ft. (30 m by 30 m) grid element per lift; measurement of dry density and moisture content are to be in accordance with ASTM D 2922 and D 3017 (nuclear methods). To establish correlations of moisture and density with the nuclear methods, the sand cone test method (ASTM D 1556) shall be used once per day when Category 1 materials are placed. The sand cone correlation will also be used to evaluate the effect impacted materials may have on the nuclear densitometer.

Compaction testing for Category 1 materials will be documented in accordance with procedures established in the *CQA Plan*.

Rework

At locations where the field testing indicates densities below the requirements of the *IMP Plan*, the failing area shall be reworked.

Lines and Grades

Surveying of lines and grades shall be conducted by the Subcontractor on a periodic basis during the depositing of the impacted materials. The CQC Consultant shall monitor the surveying to ensure that slopes are properly constructed to promote proper drainage and assure that required separation distances are maintained. Any deviation from the *IMP Plan* procedures shall be reported to the CM for corrective action.

A.4.2 Category 2 Materials (*En Masse* Placement)

Placement Quality Control

The CQC Consultant shall monitor and document that the placement of Category 2 materials is in accordance with the *IMP Plan*.

Monitoring of placement by the CQC Consultant shall include verification that:

- loose lift thickness is no more than 18 in. (450 mm) to 21 in. (530 mm));
- category 1 materials are worked into the lift as much as practical;
- horizontal extent of a lift is no more than 100 ft. (30 m) and each lift is surrounded with 10 ft. (3 m) of Category 1 material; and;
- horizons are limited to two lifts and separated vertically by a 4 ft. (1.2 m) horizon of Category 1 materials

Compaction Quality Control

The CQC Consultant shall monitor and document that the Category 2 materials have received the compaction effort specified by the *IMP Plan*. Category 1 materials used to cover each lift of Category 2 material shall be tested in accordance with Section A.4.1.

Compaction testing of Category 1 materials covering the Category 2 material shall be documented in accordance with procedures established in the *CQA Plan*.

Rework

At locations where the field testing indicated densities below the requirements of the *IMP Plan*, the failing area shall be reworked.

A.4.3 Category 3 Items (Individual Items)

Placement Quality Control

The CQC Consultant shall monitor and document that the placement procedures presented in Section 8 of this *IMP Plan* are followed by the Subcontractor in the placement of Category 3 items. Monitors will observe and document that the maximum lift thicknesses of Category 1 materials placed around the individually placed items are in accordance with the *IMP Plan*.

Compaction Quality Control

The CQC Consultant shall monitor and document that the Category 1 materials used in the placement of Category 3 items have received the compaction effort specified by the *IMP Plan*. Category 1 materials used in the placement of Category 3 materials shall be tested in accordance with Section A.4.1, but at a frequency as follows:

- for soil cover lifts, once per each soil cover lift, and

- for side berms, once per 250 ft. length but not less than twice per grid element.

Compaction testing of Category 1 materials used in the placement of Category 3 items shall be documented in accordance with procedures established in the *CQA Plan*.

Rework

At locations where the field testing indicates densities below the requirements of the *IMP Plan*, the failing area shall be reworked.

A.4.4 Category 4 Materials (Highly Compressible)

Placement Quality Control

The CQC Consultant shall monitor and document that the placement procedures presented in Section 8.0 of the *IMP Plan* are followed by the Subcontractor in the placement of Category 4 materials. Monitors shall observe and document that maximum loose lift thicknesses are in accordance with the *IMP Plan*.

Compaction Quality Control

The CQC Consultant shall monitor and document that the Category 4 materials, and the Category 1 materials used in the placement of Category 4 materials, have received the compacting effort specified by the *IMP Plan*. Category 1 materials used in the placement of Category 4 materials shall be tested in accordance with Section A.4.1, but at a frequency as follows:

- for side berms, once per 250 ft. length but not less than twice per grid element; and

- for cover lifts, once per each soil cover lift.

Compaction testing for Category 1 materials will be documented in accordance with procedures established in the *CQA Plan*.

Rework

At locations where the field testing indicates densities below the requirements of the *IMP Plan*, the failing area shall be reworked.

A.4.5 Category 5 Materials (Special Handling, Placement and Compaction)

Placement Quality Control

The CQC Consultant shall monitor and document that the placement procedures, trench/excavation dimensions or berm heights, maximum loose left thicknesses, and compacted height of final soil lifts are in accordance with the *IMP Plan* (or its appropriate addenda).

Compaction Quality Control

Highly Compressible Materials and Piping Containing Asbestos Insulation

The CQC Consultant shall monitor and document that the Category 1 materials used in the placement of these Category 5 materials (*IMP Plan* Sections 8.6.3 and 8.6.4, respectively) have received the compaction effort specified by the *IMP Plan*. Category 1 materials used in the placement of these Category 5 materials shall be tested in accordance with Section A.4.1, but at a frequency as follows:

- for initial soil cover lifts in trenches or excavations, no testing is necessary or desired aside from observing compaction passes; and
- for subsequent soil cover lifts in trenches or excavation, once per each soil cover lift in each trench or excavation.

Compaction testing of Category 1 materials used in the placement of these Category 5 materials shall be documented in accordance with procedures established in the *CQA Plan*.

Sludges

The CQC Consultant shall monitor and document that the Category 1 materials used in the placement of these Category 5 materials, and these Category 5 materials themselves, have received the compaction effort specified by the *IMP Plan*.

Category 1 materials used in the placement of sludges shall be tested in accordance with Section A.4.1, but at a frequency as follows:

- for side berms, once per 250 ft. (76 m) but not less than a minimum of two per grid element; and
- for soil cover, once per each soil cover lift in each placement unit.

Compaction testing of these Category 5 materials, and Category 1 materials used in the placement of these Category 5 materials, shall be documented in accordance with procedures established in the *CQA Plan*.

A.5 AS-PLACED PLANS

The CQC Consultant shall prepare as-placed plans for the completed impacted-materials placement activities. These plans shall report how much of each category of impacted material is in each grid element by lift with each cell. The Subcontractor shall allow for this activity in the scheduling of impacted materials placement and shall promptly furnish appropriate sketches, notes, files, and records to the CQC Consultant.

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APPENDIX B

BEST AVAILABLE TECHNOLOGY DETERMINATION FOR REMEDIATION CONSTRUCTION ACTIVITIES ON THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Category	Remediation Activities/Areas Included	Standard or Site-Specific Limit	Dust Controls/Work Practices *
Project field activities and material handling/vehicle traffic on storage piles	Activities: • Excavation • Trenching • Loading/Unloading • Transportation to defined roadway (paved or unpaved) • Load-in/Load-out on storage piles • Material placement in Onsite Disposal Cell • Vehicle traffic on storage piles Areas: • Working faces • Transition areas between working faces and defined roadways (paved or unpaved) • Onsite Disposal Cell • Storage piles	Standard: Visible particulate emissions from project field activities/areas shall not exceed twenty percent (20%) opacity as a three minute average. (OAC 3745-17-07 (B)(1))	• Apply dust suppression agents. • Minimize the amount of unnecessary traffic in and around field activities. • Limit speed to 15 mph or less during operation of equipment or vehicles. • Reduce rate of excavation. • Minimize height of drop during loading and unloading. • Change method of excavation & transport (i.e., from front end loader dumping into a truck to a self-propelled pan). • Apply dust suppression agents such as surfactants or crusting agents to storage piles. • Apply appropriate dust suppression agents such as water or surfactants to materials being transported by truck load beds to ensure the transported materials will not become airborne; cover truck load beds when transported materials are still likely to become airborne.

* to be applied progressively as environmental conditions dictate.

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Category	Remediation Activities/Areas Included	Standard or Site-Specific Limit	Dust Controls/Work Practices *
Paved roadways and paved parking areas	Activities: • Hauling materials and equipment • Vehicle and equipment traffic Areas: All predetermined areas designed and improved specifically for vehicle traffic. Improvements include the application of materials such as asphalt or concrete that forms a firm level surface for travel.	Limit: There shall be no visible particulate emissions from any paved roadway or paved parking area except for a period of time not to exceed one minute during any sixty-minute observation period.	• Apply dust suppression agents. • Minimize the amount of unnecessary traffic on paved roadways used for hauling materials and vehicle/equipment traffic. • Limit speed to 15 mph or less during operation of equipment or vehicles. • Apply appropriate dust suppression agents such as water or surfactants to materials being transported by truck load beds to ensure the transported materials will not become airborne; cover truck load beds when transported materials are still likely to become airborne. • Wheel wash prior to entering paved roadways or paved parking areas. • Wet sweep or otherwise remove any clods, clumps, tracks, or visible deposits of soil or mud from paved roadways or paved parking areas, applying appropriate dust control measures to suppress the generation of visible dust that may result from the sweeping or removal process. • Repair or resurface paved roadways/parking areas as needed.
Unpaved roadways, unpaved parking areas, and wind erosion from storage piles	Activities: • Hauling materials and equipment • Vehicle and equipment traffic Areas: All predetermined areas designed and improved specifically for vehicle traffic. Improvements include the application of gravel, shredded shingles, cinders, compaction, etc. to the delineated areas	Limit: There shall be no visible particulate emissions from any unpaved roadway, unpaved parking area, or wind erosion from a storage pile except for a period of time not to exceed three minutes during any sixty-minute observation period.	• Apply dust suppression agents. • Minimize the amount of unnecessary traffic on unpaved roadways or unpaved parking areas. • Limit speed to 15 mph during operation of equipment or vehicles • Apply dust suppression agents such as surfactants or crusting agents to storage piles or cover with tarpaulin, plastic etc.,if practical; for extended periods of planned inactivity, vegetate as a last resort if protective cover or periodic application of crusting agent proves ineffective. • Apply appropriate dust suppression agents such as water or surfactants to materials being transported by truck load beds to ensure the transported materials will not become airborne; cover truck load beds when transported materials are still likely to become airborne. • Wheel wash prior to entering unpaved roadways or unpaved parking areas. • Remove, as practical, any clods, clumps, tracks, or visible deposits of soil or mud from unpaved roadways or unpaved parking areas. • Repair or resurface roadways/parking areas as needed or use an alternative road surface as a last resort.

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SPECIALIZED PLACEMENT PLAN NO. 1

OVERSIZED METALS AND OVERLENGTH STRUCTURAL STEEL BEAMS/COLUMNS

Supplement to

IMPACTED MATERIALS PLACEMENT PLAN ON-SITE DISPOSAL FACILITY

Revision A
August 1997

United States Department of Energy

Fernald Environmental Management Project
Fernald, Ohio

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1.0 INTRODUCTION

Section 8.6 of the "Impacted Materials Placement Plan, On-Site Disposal Facility," 20100-PL-007, Revision H, August 1997 (IMP Plan) discusses requirements for placing Category 5 Materials (Special Handling, Placement and Compaction) in the Fernald Environmental Management Project (FEMP) On-Site Disposal Facility (OSDF), Fernald, Ohio. Section 8.6.1, Introduction, of the IMP Plan states: "Category 5 materials are materials that require special handling, placement and compaction procedures. These materials will be classified and designated in accordance with the approved Records of Decision and the waste acceptance criteria. Materials either nominally larger than the physical criteria for the OSDF as identified in Section 4.3 Physical Criteria of this IMP Plan, or not reasonably anticipated by the currently identified categories in this IMP Plan, will require specialized placement plans to be developed on an as-needed basis. Such plans would be developed by the OSDF project with the assistance of the resident engineer as appropriate, and submitted to the regulatory agencies for review and approval prior to utilization."

The purpose of this Specialized Placement Plan No. 1 is to present the special handling, placement and compaction procedures associated with the disposal of certain oversized metals (mill rolls, mill stands, and machine stands) and overlength (i.e., length greater than 10 ft (3 m) but no more than 20 ft (6 m)) structural steel beams/columns in the OSDF.

2.0 DESCRIPTION OF MATERIAL

Oversize metals considered in this plan include mill rolls, mill stands, and machine stands (including lathe beds). All of these items represent solid metal objects requiring disposal in the OSDF. Mill rolls are cylinder-shaped objects, 1.5 to 2.5 ft (0.24 to 0.76 m) in diameter, 10 to 20 ft (3 to 6 m) long, with each weighing between 8,700 and 40,000 lb (40 to 180 kN). It is estimated that approximately 40 mill rolls will require disposal in the OSDF. Mill stands are 1 to 2 ft (0.3 to 0.6 m) high, 3 to 10 ft (0.9 to 3 m) wide, and 3 to 12 ft (0.9 to 3.6 m) long. Each mill stand weighs between 1,000 and 6,000 lb (5 to 27 kN). It is estimated that less than 10 mill stands will require OSDF disposal. Machine stands are 1 to 3 ft (0.3 to 0.9 m) high, 1 to 4 ft (0.3 to 1.2 m) wide, and 10 to 15 ft (3 to 4.6 m) long, with each weighing 1,000 to 4,000 lb (5 to 18 kN). It is estimated that approximately eight machine stands will require OSDF disposal.

Structural steel beams/columns include a variety of structural shapes including wide-flange, channel, and angle sections. The IMP Plan has been interpreted to limit the length of structural steel members in the OSDF to 10 ft (3 m). This Specialized Placement Plan No. 1 is intended to extend the length limit for structural steel beams/columns to 20 ft (6 m). It is currently estimated that a maximum of 14,000 overlength structural steel members will be disposed of in the OSDF.

4.0 COMPACTION PROCEDURES

Each lift of soil (Category 1 material) between the oversized metals and overlength structural steel members with maximum cross-sectional dimension greater than 9 in. (225 mm) shall be compacted using driven or walk-behind mechanized compaction equipment capable of achieving at least 90 percent of the standard Proctor maximum dry density. It is anticipated that the compaction moisture content for this Category 1 material will be within ±3 percentage points of the material's standard Proctor optimum moisture content. Specific requirements for compaction moisture content will be established by the CM during construction. These requirements will take into account the workability of the soil, the required soil shear strength to obtain adequate levels of OSDF stability, moisture contents needed to achieve dust and other fugitive emission control, and material trafficability.

For structural steel members with maximum cross-sectional dimension less than 9 in. (225 mm) and placed 3 in. (75 mm) apart, the members shall be infilled and covered with a cohesionless sand or other suitable material evaluated by the CM as capable of completely infilling the space between members. The material shall be compacted so that the structural members are completed infilled. Compaction shall consist of at least three full coverage passes of a driven or walk-behind smooth drum vibratory roller. The CM may specify additional compaction requirements if needed to achieve complete infilling.

A final 12-in. (300-mm) thick compacted lift of soil (Category 1 material) shall be placed above the oversized metals, overlength structural steel, and cohesionless sand (or other suitable material) layer used for infilling. This final compacted lift should be proof-rolled using equipment with a minimum gross vehicle weight of 20 tons (180 kN) and exert a ground pressure of at least 65 psi (460 kPa). Soft spots indicated by tire ruts more than 2 in (50 mm) in depth or visible deflection under the moving proof rolling equipment shall be stabilized through additional passes of the compactor. Any soft spot that cannot be stabilized with further compactive effort shall be cause for additional treatment to the satisfaction of the CM. This treatment shall consist of removal, replacement, and recompaction of the soil (Category 1 material), and, if needed, infilling soft spots/areas around the oversized material with grout or other material approved by the CM.

GEOSYNTEC CONSULTANTS

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19 August 1997

Mr. Michael A. Hickey
Project Coach, On-Site Disposal Facility
Fluor Daniel Fernald
P.O. Box 538704
Cincinnati, Ohio 45253-8704

Subject: Evaluation of Overlength Structural Steel Disposal
On-Site Disposal Facility
Subcontract No. 95PS005028

Dear Mr. Hickey:

The purpose of this letter is to summarize the results of GeoSyntec Consultants' (GeoSyntec's) evaluation of the placement of overlength structural steel members in the Fernald Environmental Management Project (FEMP) On-Site Disposal Facility (OSDF).

The Impacted Material Placement Plan (IMP Plan) for the OSDF has been interpreted to limit the length of structural steel members in the OSDF to 10 ft (3 m). GeoSyntec understands that Fluor Daniel Fernald (FDF) would like to establish a 20-ft (6-m) maximum length criterion for structural steel members to be disposed in the OSDF. It is understood that the number of overlength structural steel members will not exceed 14,000 and the total volume of this material is estimated to be about 2,500 cubic yards (1,900 m^3). This volume is less than 0.1 percent of the total disposal volume of the OSDF.

For the evaluation, GeoSyntec reviewed the original design analyses for the OSDF and the following two documents it previously prepared to address the issue of oversized material disposal in the OSDF.

- "*Disposition of Oversized Items, On-Site Disposal Facility*", report prepared by GeoSyntec Consultants for Fluor Daniel Fernald, dated 23 May 1997; and
- "*Evaluation of Disposal of Oversized Objects in OSDF*", public meeting handout prepared by GeoSyntec Consultants for Fluor Daniel Fernald, dated June 1997.

The documents cited above demonstrate that the OSDF can receive the anticipated volume of overlength structural steel without any adverse impact to the liner system, final cover system, or other engineered components of the OSDF. This conclusion is based on the following evaluation results:

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- inclusion of the overlength structural steel will not adversely affect OSDF slope stability;

- inclusion of the overlength structural steel will not significantly increase OSDF foundation settlement;

- inclusion of the overlength structural steel will not significantly increase the compressive stress applied to the liner system;

- structural steel is solid metal and thus has no potential to collapse or create voids in the waste mass; and

- all structural steel members will be encapsulated by at least a 4-ft (1.2-m) combined thickness of protective, contouring, and select material soil layers; these layers all but eliminate any potential for structural steel members to puncture or otherwise damage the OSDF liner system, final cover system, or other engineered components.

GeoSyntec's evaluation also resulted in the development of specialized procedures for the placement of overlength structural steel members in the OSDF. These specialized procedures are described in "*Specialized Placement Plan No. 1, Oversized Metals and Overlength Structural Steel Beam Columns, Supplement to Impacted Material Placement Plan, On-Site Disposal Facility*", August 1997 (Revision A), prepared by GeoSyntec. Overlength structural steel disposal in the OSDF should be performed in accordance with these specialized procedures, once they are fully approved.

Please contact either of the undersigned if you have any questions or require additional information regarding this matter.

Sincerely,

RB for

Kenneth W. Cargill, P.E.
Associate

Rudy Bonaparte

Rudolph Bonaparte, Ph.D., P.E.
Principal

GQ0166-05/F9730038

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23 May, 1997

Mr. Mike Hickey
Fluor Daniel Fernald
P.O. Box 538704
Cincinnati, Ohio 45253-8704

Subject: Disposition of Oversized Items
On-Site Disposal Facility
Subcontract No. 95PS005028

Dear Mr. Hickey:

The purpose of this letter is to summarize the evaluation by GeoSyntec Consultants (GeoSyntec) of the impact of disposing oversize metal objects in the On-Site Disposal Facility (OSDF) at the Fernald site. This letter is a revision of the 20 February 1997 GeoSyntec letter on the above subject and incorporates Fluor Daniel Fernald (FDF) comments on the previous letter. This evaluation was authorized in a 23 December 1996 telephone conversation between Mr. Rick Holbrook of FDF and Mr. Ken Cargill of GeoSyntec. The remainder of this letter report is organized as follows: (i) the size, shape, and volume of oversized metal objects are described; (ii) the impact of the oversized objects on OSDF stability is presented; (iii) the impact of the oversized objects on settlement is presented; (iv) the impact of the objects on the lining and closure system integrity is presented; and (v) procedures for placing oversized objects in the OSDF are described.

DESCRIPTION OF OVERSIZED OBJECTS

The oversized objects were described in a Modification to the Statement of Work to the above referenced subcontract dated October 1996. The objects are generally described as:

- metal vessels 1 to 5 ft in diameter and 5 to 20 ft long weighing from about 55 to 12,700 lbs;
- motors and generators weighing from about 1,000 to 3,200 lbs;
- gear boxes up to 4 ft x 4 ft x 4 ft and weighing from about 330 to 6,300 lbs;

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- mill rolls 1.5 to 2.5 ft in diameter and 10 to 20 ft long weighing from about 8,600 to 40,100 lbs;
- mill stands weighing about 1,000 to 6,000 lbs;
- shop equipment weighing about 1,500 to 8,000 lbs;
- Compressors weighing about 1,400 to 2,000 lbs; and;
- small white metal boxes weighing 680 to 6,800 lbs.

For the most part, the objects are solid metal; however, some of the objects such as vessels and gear boxes are reported to be hollow or partially hollow. Hollow objects are to be filled as subsequently described as part of placement procedures. The small white metal boxes are reported to contain bricks impacted with asbestos. The bricks are reported to be dumped into the boxes. For the most part, the objects are smaller than 4 ft (1.2 m), the current maximum dimension normally allowed in the impacted material placement plan. However, some of the vessels and other objects have greater dimensions.

The total volume of oversized objects was verbally reported to be 10,000 to 20,000 yd^3. This volume is less than 1 percent of the total OSDF capacity based on a design capacity of 2,800,000 yd^3. For stability and settlement analyses, GeoSyntec has assumed that 1 and 5 percent of the impacted material placed in localized areas of the OSDF may be oversized objects as previously described. These percentages are greater than that calculated above for the overall volume. However, these percentages allow greater flexibility in operation of the OSDF by not requiring the oversized objects to be evenly dispersed throughout all eight cells of the OSDF.

The impacted material considered in the OSDF Final Design Calculation Package had a calculated average unit weight of 125 pcf. The oversized metal objects have been conservatively assumed to have a unit weight of 490 pcf, i.e., the unit weight of solid steel. Replacing normal impacted material with a volume of metal objects having an average unit weight of 490 pcf and equivalent to 1 and 5 percent of the total disposal volume will result in average unit weights for the impacted material of 129 pcf and 143 pcf respectively. In the stability and settlement calculations, the oversized objects are assumed to be dispersed throughout the OSDF, therefore, the use of an average unit weight is appropriate.

STABILITY

Detailed stability analyses were conducted as part of the OSDF design and the results are presented in Section 3 of the Final Design Calculation Package. These analyses included both seismic and static conditions. The static cases were reviewed and six cases with the lowest calculated factors of safety for a range of geometry and operating conditions were reanalyzed. The static slope stability cases from the Final Design Calculation Package which were reanalyzed are 1A, 1C, 2APP, 2CPP, and 7B. These cases are described as follows:

- 1A - circular failure surfaces through the foundation for the impacted material in an interim configuration and using short-term material strengths;
- 1C - same as 1A except for block or wedge failure surfaces;
- 2APP - same as 1A except using long-term material strengths;
- 2CPP - same as 1C except using long-term material strengths; and
- 7B - failure surface along the geosynthetic clay liner for the final OSDF condition and using large displacement shear strengths which are a function of normal stress.

In the reanalyses, layer geometries were the same as in the original analysis, but unit weights for the impacted material were increased from 125 pcf to 129 pcf and 143 pcf. In Case 7B, the strength properties of the geosynthetic clay liner was reduced to account for the greater normal stress due to an increased unit weight of the impacted material. The calculated factors of safety for the original (i.e., unit weight of 125 pcf) and reanalyses for static slope stability are presented in Attachment A and are summarized in the table below. The required factors of safety are also reported in the table. These required factors of safety were established in the Design Criteria Package for the OSDF. Based on the results of the reanalyses, up to five percent of the volume can be replaced with oversized objects without causing the calculated factor of safety for static stability to be less than the required factor of safety.

Required and Calculated Factor of Safety (FS)				
	Required FS	Calculated FS		
		125 pcf	129 pcf	143 pcf
Case 1A	1.3	1.51	1.47	1.37
Case 1C	1.3	1.61	1.58	1.48
Case 2APP	1.5	1.76	1.72	1.60
Case 2CPP	1.5	2.01	2.12	2.11
Case 7B	1.25	1.54	—	1.40

Case 1A and Case 7B yielded the lowest calculated static stability factors of safety for short-term conditions and long-term conditions, respectively. Therefore, these cases were considered under seismic loading and the reanalyses for seismic conditions are included in Appendix B. These reanalyses indicate that the calculated deformation of 2.5 in. is below the maximum allowable permanent seismic deformation of 6 in.

SETTLEMENT

The impact of the placement of oversized objects in the OSDF on settlement was evaluated. A detailed settlement analysis was conducted as part of the OSDF design and the results are included in Section 5 of the Final Design Calculation Package. The maximum settlement was calculated under the center of the OSDF. The settlement at this point was recalculated using average unit weights of 129 pcf and 143 pcf for the impacted material. The original and recalculated settlements under the center of the OSDF are presented in Attachment B and are summarized in the table below:

Variation of Settlement with Unit Weight	
Unit Weight, pcf	**Settlement, ft**
125	2.27
129	2.32
143	2.50

The revised impacted material unit weights were also used to estimate settlement of the lining system at other points under the OSDF. The revised settlements were used to recalculate the grade change and tensile strain in the liner system. These calculations are also presented in Attachment B. The impact of the additional settlement on the grade change and tensile strain is insignificant. Therefore, placement of oversized objects in the OSDF will not impact settlement.

CONCENTRATION OF STRESS

Placement of oversized objects can result in the concentration of stress on the OSDF lining system, and therefore, potential impact was evaluated. Stress concentrations will result from the contact pressure of the oversized objects. The range of contact pressures applied by the various objects were calculated by dividing the minimum and maximum reported weights by the minimum and maximum reported areas. The greatest contact pressure for a rhombic like object was calculated for a gear box. The relative influence of the gear box is greatest when it is first placed in the OSDF. Assuming the gear box is placed directly on the top of the select impacted material, the stress concentration at the primary geomembrane surface is less than 100 psf.

A mill roll will apply a line load to the surface on which it is placed. A mill roll placed on top of the select impacted material will result in a stress concentration at the primary geomembrane surface of 255 psf.

The stress concentration at the primary geomembrane surface due to oversized objects is well below the calculated puncture resistance of 80-mil thick HDPE geomembrane, which is on the order of 14,000 psf. Based upon the above observations the select oversized objects can be placed directly on top of the select impacted material, if necessary.

DEVELOPMENT OF VOIDS

Placement of oversized material in the OSDF could result in the development of voids in the impacted waste mass. The impact of the development of voids below the cover system was addressed in Section 5 of the OSDF Final Design Calculation Package. This analysis was reviewed and determined to still be relevant to the case considered here. The analysis described above considered voids up to 15 in. in diameter developing just below the select impacted material layer. The analysis showed that this size void would result in settlements of approximately 1 in., which would not impact the cover system. Voids developing lower within the impacted material mass would have indiscernible impact on the cover system. Therefore, small voids in the impacted material are acceptable, however to be conservative, all voids should be filled.

PLACEMENT OF OBJECTS

Oversized objects are to be placed within the impacted waste mass in the same manner as noted in the Impacted Material Placement Plan for Category 3 or special Category 5 material. Exceptions are as noted below:

- the largest face of an object is to be placed flat against the existing impacted material surface;
- all objects with more than 10 percent voids need to be filled in accordance with the impacted material placement plan;
- objects should be spaced a distance equal to at least their width, a greater distance may be required to allow for backfilling and compaction;

- cylindrical vessels should be buried using the same construction procedures typically used for pipes; and
- special backfilling procedures may need to be established for uniquely shaped objects.

CLOSURE

Please contact either of the undersigned if you have any questions or if you require additional information with regard to this matter.

Sincerely,

J. F. Beech, Ph.D., P.E.
Principal

Kenneth W. Cargill, P.E.
Associate

ATTACHMENT A

REVISED FOUNDATION AND IMPACTED MATERIAL STABILITY CALCULATIONS

GEOSYNTEC CONSULTANTS

Written by: Mark Gleason Date: 28 Jan. 1997 Reviewed by: ________ Date: ________ JF3
Client: FERMCO Project: OSDF Project No.: GE3900 Task No.: 23.1 13 Feb 97

OSDF REVISED FOUNDATION AND IMPACTED MATERIAL STABILITY

EXECUTIVE SUMMARY

This calculation package contains analyses for static foundation stability and impacted material stability of the OSDF for selected interim and final configurations. The foundation stability of the OSDF is calculated for potential slip surfaces that pass through the impacted material and along the soils beneath the OSDF. The impacted material stability of the OSDF is calculated for slip surfaces that pass through the impacted material and along the liner system of the OSDF.

The analyses presented in this calculation package are identical to analyses presented in document F9530020.CD (i.e., OSDF Foundation) and in document F9530023.CD (i.e., Impacted Material Configuration), with the exception that the unit weight of the impacted material has been increased from 125 pcf to: (i) 129 pcf; and (ii) 143 pcf. This increase in impacted material unit weight is to account for the possibility of additional ~~steel~~ metal debris in the impacted material.

should be checked

Minimum acceptable factors of safety (FS) based on UMTRA Technical Approach Document (DOE, 1989) are as follows: (i) long-term stability, FS > 1.5; and (ii) end of construction (interim/short-term) stability, FS > 1.3. For potential slip surfaces involving the geosynthetic clay liner, the long term slope stability factor of safety using large displacement shear strengths for the geosynthetic clay liner. The slope stability factor of safety for this condition should be at least 1.25 (Bonaparte et al. (1996)). PJS 20 Feb 97

Based on the calculations provided in this package, all factors of safety meet the established criteria.

JTB
13 Feb 97

CALCULATION PACKAGE

PURPOSE

The purpose of this document is to provide revised engineering calculations for the OSDF foundation and impacted material stability. This calculation package represents an amendment to the original calculations that are presented in the OSDF Final Design Calculation Package. The original calculations are provided in document F9530020.CD (i.e., OSDF Foundation) and in document F9530023.CD (i.e., Impacted Material Configuration). The calculations contained in this document are performed with a revised unit weight for the impacted material. The unit weight of the impacted material is increased from 125 pcf to: (i) 129 pcf; and (ii) 143 pcf. The reason for this increased unit weight is to account for the effect of additional ~~steel~~ metal content in the impacted material on the stability of the OSDF.

The calculations contained in this package provide an analysis of the resistance to failure of the OSDF for potential slip surfaces that pass through the impacted material mass and the foundation soils beneath the OSDF. One calculation in this package provides an analysis of the resistance to failure of the OSDF for potential slip surfaces that pass through the impacted material mass and along the liner system of the OSDF.

PROCEDURE

The calculation procedures for the foundation and impacted material stability analyses are described in detail in the Design Criteria Package, and are summarized in documents F9530020.CD and F9530023.CD. The data used for the analyses (i.e., material unit weight, undrained and drained shear strengths, and interface shear strengths) are provided in the Data Verification Section of this document.

The computer program XSTABL (Sharma, 1994) is used to perform the stability analyses. Circular and wedge-type slip surfaces are examined depending on the

JFB
13 Feb 97

condition. Circular slip surfaces are analyzed using Bishop's Simplified Method (Bishop, 1955). Wedge slip surfaces are analyzed using Janbu's Simplified Method (Janbu, 1973) and Spencer's Method (Spencer, 1973).

ANALYSIS

For a detailed discussion of the analysis and methods used in the calculations for the OSDF foundation stability and for the impacted materials configuration stability, refer to the original calculation package for each condition (i.e. documents F9530020.CD and F9530023.CD).

In this calculation package, calculations are performed for the final OSDF configuration and for the interim OSDF configuration for foundation stability and for the final OSDF configuration for the impacted material stability along the OSDF liner system.

Minimum acceptable factors of safety (FS) based on UMTRA Technical Approach Document (DOE, 1989) are as follows: (i) long-term stability, FS > 1.5; and (ii) end of construction (interim/short-term) stability, FS > 1.3.
Minimum FS for long term, large displacement at a GCL interface is 1.25 [Bonaparte et al., 1996]. PJS 20Feb97

DATA VERIFICATION

As stated in the Purpose section of this calculation package, these calculations are performed to calculate stability of the OSDF using an impacted material unit weight that is higher than that used in the original calculations. The increased unit weight represents the potential for a greater percentage of ~~steel~~ metal debris in the impacted material than was originally used in the calculations (i.e., original unit weight is 125 pcf).

The revised unit weights are as follows:
1 - revised unit weight equal to 129 pcf.
2 - revised unit weight equal to 143 pcf.

Refer to the original calculation package provided in document F9530020.CD (i.e., OSDF Foundation) and in document F9530023.CD (i.e., Impacted Material Configuration) for all other data used in these analyses. The data used in this analysis (with the exception of impacted material unit weight) are identical to the data used in the original analyses.

RESULTS

The stability analyses were performed on selected configurations for the OSDF foundation and for the impacted material configuration that are considered to represent the most critical conditions. A brief description of each configuration, the factor of safety calculated in the original analysis, and the factor of safety calculated for an impacted material unit weight of 129 pcf and 143 pcf is presented in the following table.

			Calculated Factor of Safety		
OSDF Stability Condition	**Analysis Type**	**File Name**	**unit wt. 125 pcf.**	**unit wt. 129 pcf.**	**unit wt. 143 pcf.**
Foundation - interim, short-term	circular	Case1A	1.51	1.47	1.37
Foundation - interim, short-term	block	Case1C	1.61	1.58	1.48
Foundation - interim, long-term	circular	Case2APP	1.76	1.71	1.60
Foundation - interim, long-term	block	Case2CPP	2.01	2.12	2.11
Impacted Material, long-term	block	Case7B	1.54	1.54	1.52
Impacted Material, long term, large displacement	block	Case7B3	1.54	–	1.40

PJS 20Feb97

Based on the results presented above, the factor of safety for all short-term configurations exceeds the established minimum of 1.3, and the factor of safety for all long-term configurations exceeds the established minimum of 1.5. Therefore, all factors of safety meet the established criteria. The long term, large displacement FS for sliding on a GCL interface is also greater than 1.25. PJS 20Feb97

GEOSYNTEC CONSULTANTS

Written by: Mark Gleason Date: 28 Jan. 1997 Reviewed by: [illegible] Date: [illegible] 5/45
Client: FERMCO Project: OSDF Project No.: GE3900 Task No.: 23.1 JFB 13 Feb 97

REFERENCES

Bishop, A.W., "*The Use of the Slip Circle in the Stability Analysis of Slopes*", Geotechnique, V.5, 1955, pp.7-17.

Janbu, N., "*Slope Stability Calculations in Embankment Dam Engineering*", Casagrande Memorial Volume, Hirschfield and Poulos, (Eds.) John Wiley, NY, 1973, pp.47-86.

Sharma, S., "*XSTABL: An Integrated Slope Stability Analysis Program for Personal Computers*", Version 5, Interactive Software Designs, Moscow, ID, 1994.

Spencer, E., "*The Thrust Line Criterion in Embankment Stability Analysis*", Geotechnique, Vol. 23, no. 1, pp. 85-100, 1973.

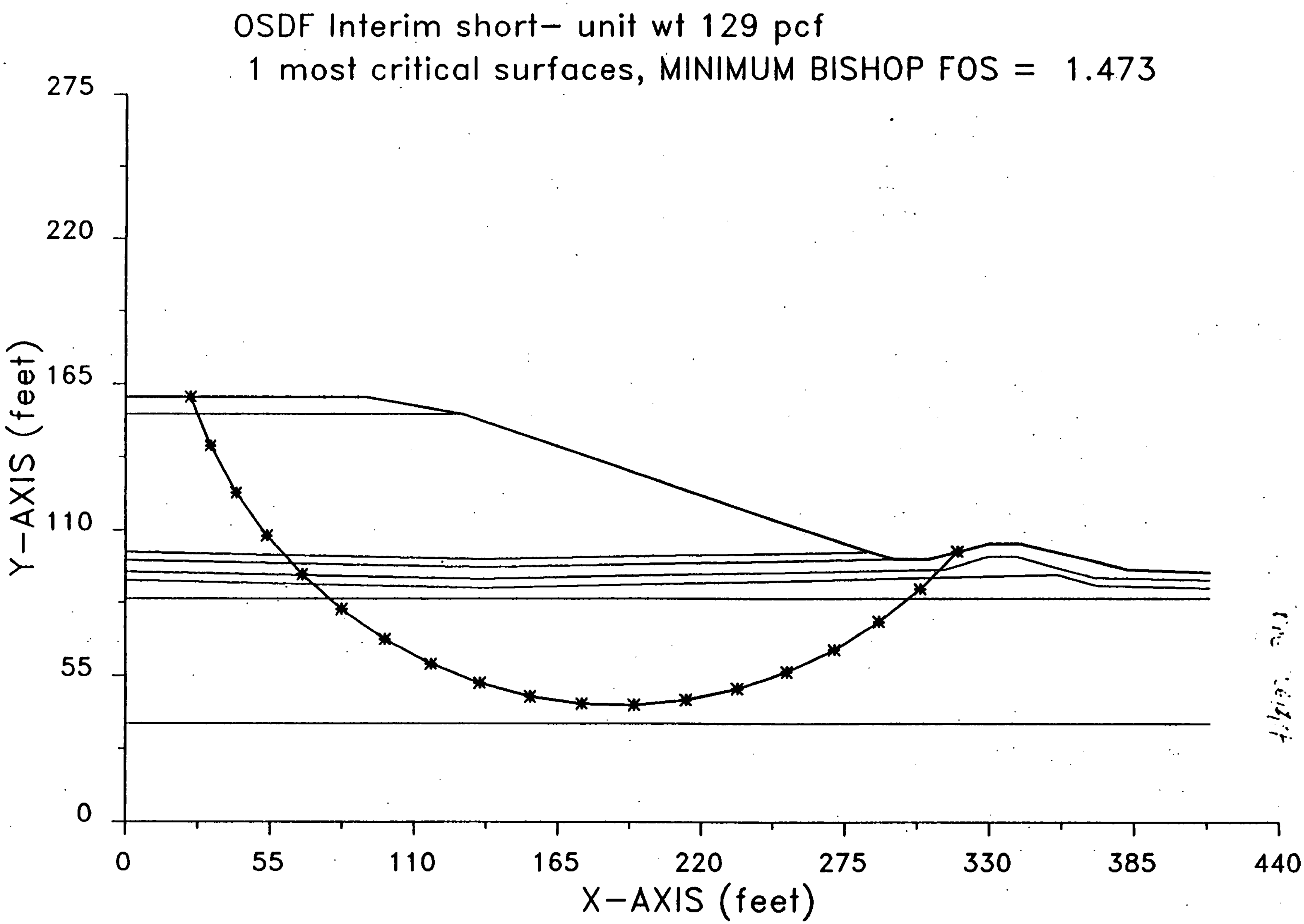
Bonaparte, R., Othman, M.A., Rad, N.R., Swan, R.H., and Vander Linde, D.L., "Evaluation of Various Aspects of GCL Performance," *Proceedings of Geosynthetic Clay Liner Workshop*, U.S. Environmental Protection Agency, Cincinnati, Ohio, August 1995, in press.

6/45

XSTABL Analyses

Impacted Material Unit Weight = 129 pcf

CASE1A1 1-27-97 14:29



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XSTABL File: CASE1A1   1-27-97   14:29

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X S T A B L

Slope Stability Analysis
using the
Method of Slices

Ver. 5.100   95 - 1305
****

Problem Description : OSDF Interim short- unit wt 129 pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	129.0	129.0	200.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	1200.0	.00	.000	.0	0
4	135.0	135.0	1200.0	.00	.000	.0	0
5	145.0	145.0	1900.0	.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 318.0 ft
and x = 348.0 ft

Each surface terminates between x = 5.0 ft
and x = 30.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

20.0 ft line segments define each trial failure surface.

MHB 27 Jan 97

ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 19 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	318.00	101.87
2	303.86	87.73
3	288.18	75.31
4	271.17	64.78
5	253.07	56.28
6	234.11	49.93
7	214.54	45.80
8	194.62	43.95
9	174.63	44.41
10	154.82	47.17
11	135.46	52.19
12	116.81	59.41
13	99.12	68.74
14	82.61	80.04
15	67.52	93.16
16	54.05	107.94
17	42.36	124.17
18	32.62	141.64
19	25.01	160.00

**** Simplified BISHOP FOS = 1.473 ****

The following is a summary of the TEN most critical surfaces

Problem Description : OSDF Interim short- unit wt 129 pcf

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.473	188.60	217.14	173.29	318.00	25.01	1.082E+08
2.	1.473	179.30	226.64	186.56	318.00	5.10	1.239E+08
3.	1.474	180.58	228.38	187.67	319.58	5.87	1.246E+08
4.	1.474	187.89	220.23	175.89	318.00	22.69	1.103E+08
5.	1.475	181.71	229.38	188.40	321.16	6.64	1.252E+08
6.	1.475	189.04	220.34	176.01	319.58	23.79	1.105E+08
7.	1.475	180.68	229.24	189.07	321.16	4.94	1.267E+08
8.	1.475	185.14	223.29	180.87	319.58	16.00	1.168E+08
9.	1.475	186.02	221.92	178.42	318.00	18.93	1.134E+08
10.	1.476	191.13	218.83	174.34	321.16	27.04	1.089E+08

*** END OF FILE ***

MHB 27 Jan 97

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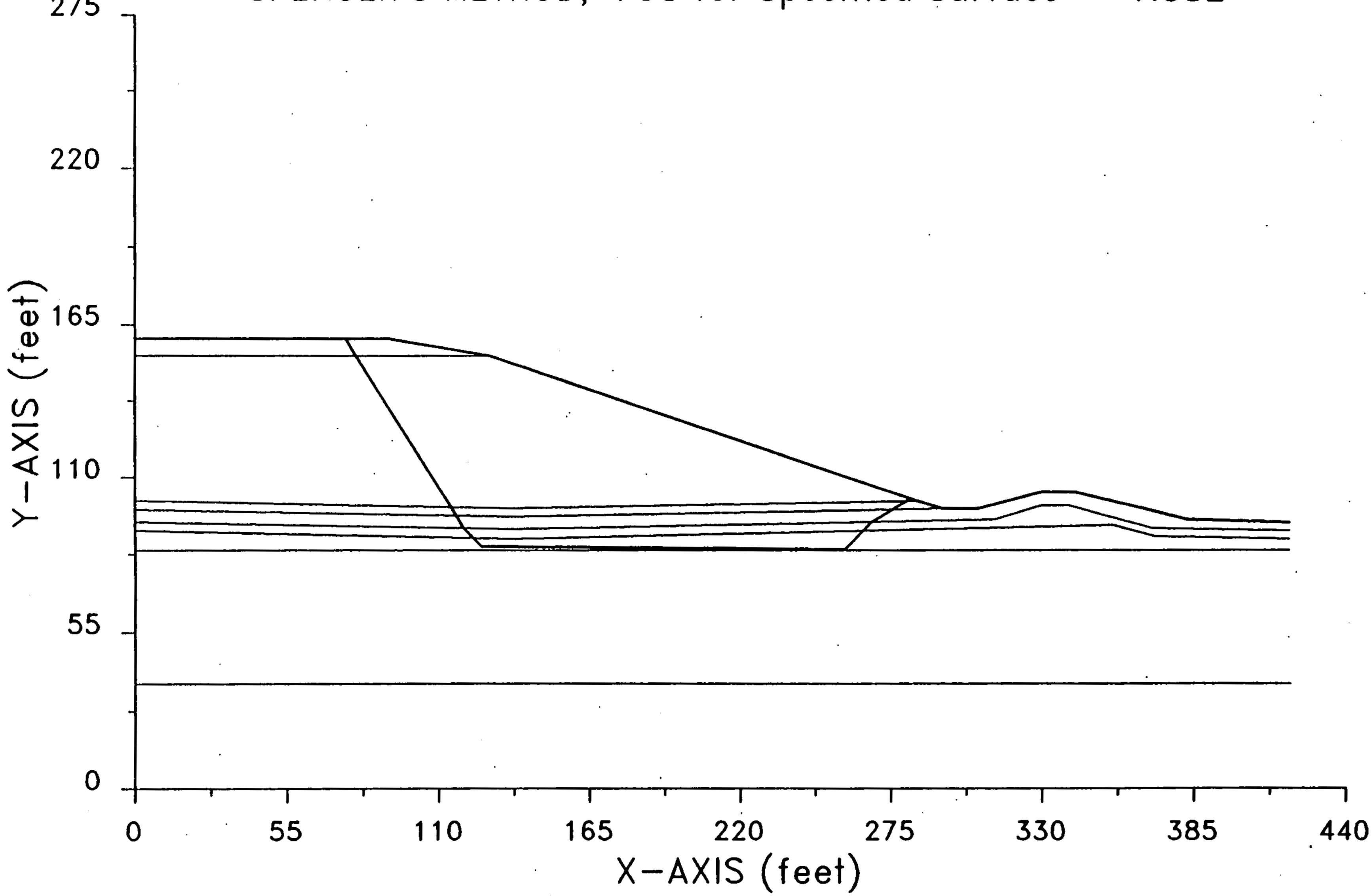
OSDF Interim short - unit wt 129pcf

SPENCER'S METHOD, FOS for Specified Surface = 1.582



MHG 27 Jan 97

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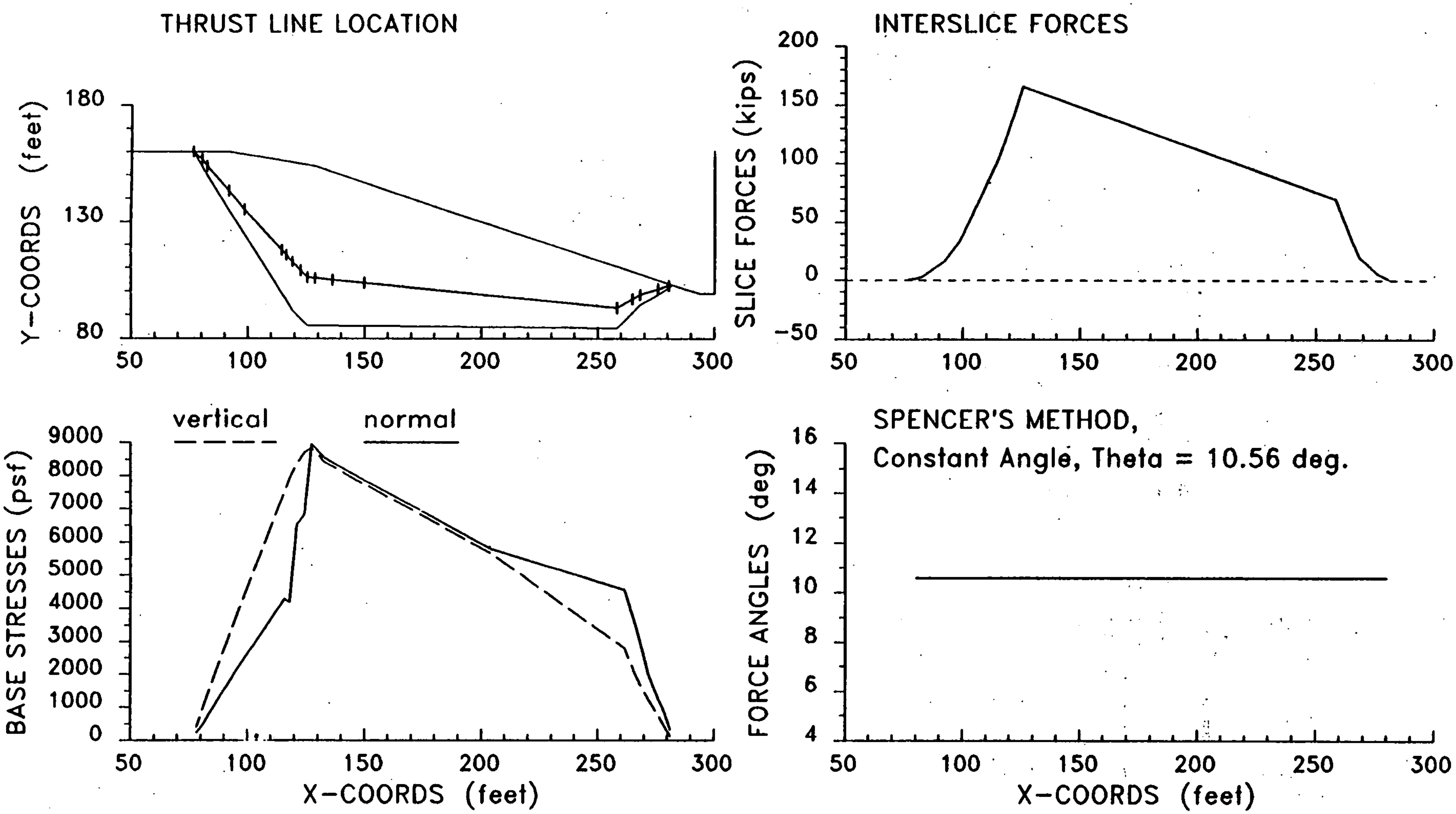

OSDF Interim short - unit wt 129pcf
SPENCER'S METHOD, FOS for Specified Surface = 1.582

MHG 27 Jun 97

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*                 X S T A B L               *
*                                           *
*         Slope Stability Analysis          *
*                 using the                 *
*             Method of Slices              *
*                                           *
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*  Ver. 5.100                 95 - 1305     *
*********************************************
```

Problem Description : OSDF Interim short - unit wt 129pcf

SEGMENT BOUNDARY COORDINATES
----

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	420.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	420.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	420.0	88.0	4
16	.0	84.0	420.0	84.0	5
17	.0	37.0	420.0	37.0	6

0001002

ISOTROPIC Soil Parameters
----

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	129.0	129.0	200.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	1200.0	.00	.000	.0	0
4	135.0	135.0	1200.0	.00	.000	.0	0
5	145.0	145.0	1900.0	.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 15 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	282.15	102.55
2	280.52	101.52
3	276.01	98.65
4	268.16	94.11
5	264.98	90.93
6	258.41	84.36
7	125.76	85.38
8	122.84	88.30
9	119.30	91.84
10	116.73	96.29
11	114.80	99.33
12	98.68	124.63
13	82.56	149.93
14	80.22	153.60
15	76.53	160.00

MHa 27 Jan 97

****
SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	281.33	102.03	.79	1.63	-32.29	18.43	166.
2	278.26	100.08	3.76	4.51	-32.47	18.43	2187.
3	276.01	98.65	5.95	.01	-30.04	18.43	6.

4	272.08	96.38	9.53	7.84	-30.04	18.43	9571.
5	266.57	92.52	15.23	3.18	-45.00	18.43	6202.
6	261.69	87.64	21.73	6.57	-45.00	18.43	18435.
7	204.21	84.78	43.75	108.41	.44	18.43	613461.
8	143.25	85.25	63.60	13.50	.44	18.43	108122.
9	132.75	85.33	67.02	7.50	.44	18.43	63262.
10	127.38	85.37	68.51	3.24	.44	9.81	28641.
11	124.30	86.84	67.57	2.92	45.00	9.81	25430.
12	121.07	90.07	64.90	3.54	45.00	9.81	29562.
13	118.01	94.07	61.43	2.57	59.99	9.81	20329.
14	115.76	97.81	58.08	1.93	57.59	9.81	14437.
15	106.74	111.98	45.47	16.12	57.50	9.81	94306.
16	95.34	129.87	29.55	6.68	57.50	9.81	25308.
17	87.28	142.52	17.48	9.44	57.50	.00	21042.
18	81.39	151.76	8.24	2.34	57.48	.00	2426.
19	78.38	156.80	3.20	3.69	60.03	.00	1476.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	10.2274	1.5723	1.7464
3	10.5718	1.5820	1.5723
4	10.5617	1.5817	1.5820

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	320.0	200.0	25.00	0.	0.	0.	.00
2	922.4	200.0	25.00	0.	0.	0.	.00
3	1296.3	200.0	25.00	0.	0.	0.	.00
4	1990.8	.0	30.00	0.	0.	0.	.00
5	3501.0	1200.0	.00	0.	0.	0.	.00
6	4557.3	1200.0	.00	0.	0.	0.	.00
7	5786.0	1200.0	.00	0.	0.	0.	.00
8	8133.0	1200.0	.00	0.	0.	0.	.00
9	8558.3	1200.0	.00	0.	0.	0.	.00
10	8962.7	1200.0	.00	0.	0.	0.	.00
11	6819.4	1200.0	.00	0.	0.	0.	.00
12	6518.4	1200.0	.00	0.	0.	0.	.00
13	4191.5	.0	30.00	0.	0.	0.	.00
14	4290.7	200.0	25.00	0.	0.	0.	.00
15	3337.8	200.0	25.00	0.	0.	0.	.00
16	2125.3	200.0	25.00	0.	0.	0.	.00
17	1208.1	200.0	25.00	0.	0.	0.	.00
18	507.1	200.0	25.00	0.	0.	0.	.00
19	211.9	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	281.33	320.0	101.6	.0	220.8
2	278.26	922.4	485.2	.0	398.4
3	276.01	1296.3	767.6	.0	508.6
4	272.08	1990.8	1220.4	.0	726.7
5	266.57	3501.0	1948.1	.0	758.7
6	261.69	4557.3	2807.5	.0	758.7
7	204.21	5786.0	5658.7	.0	758.7
8	143.25	8133.0	8009.0	.0	758.7
9	132.75	8558.3	8435.0	.0	758.7
10	127.38	8962.7	8839.9	.0	758.7
11	124.30	6819.4	8708.1	.0	758.7
12	121.07	6518.4	8350.9	.0	758.7
13	118.01	4191.5	7908.6	.0	1529.9
14	115.76	4290.7	7483.0	.0	1391.4
15	106.74	3337.8	5850.3	.0	1110.4
16	95.34	2125.3	3788.7	.0	753.0
17	87.28	1208.1	2229.1	.0	482.6
18	81.39	507.1	1036.7	.0	275.9
19	78.38	211.9	400.0	.0	77.3

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	280.52	10.56	702.	.67	1.58	.424
2	276.01	10.56	5221.	2.19	5.95	.369
3	276.00	10.56	5230.	2.20	5.95	.369
4	268.16	10.56	20213.	4.34	13.10	.331
5	264.98	10.56	34007.	5.59	17.35	.322
6	258.41	10.56	69516.	8.54	26.10	.327
7	150.00	10.56	148273.	18.22	61.41	.297
8	136.50	10.56	157833.	19.46	65.80	.296
9	129.00	10.56	163119.	20.14	68.24	.295
10	125.76	10.56	165392.	20.44	68.78	.297
11	122.84	10.56	147388.	20.42	66.37	.308
12	119.30	10.56	126647.	20.64	63.44	.325
13	116.73	10.56	111671.	19.17	59.43	.323
14	114.80	10.56	101137.	18.35	56.73	.324
15	98.68	10.56	33445.	10.63	34.21	.311
16	92.00	10.56	15896.	8.03	24.89	.323
17	82.56	10.56	2323.	3.71	10.07	.369
18	80.22	10.56	1086.	2.86	6.40	.446
19	76.53	.00	-3.	-.16	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 4601.13 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 764.54 (psf)

Total Length of failure surface = 252.40 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.582

Total shear strength available along specified failure surface = 305.23E+03 lb

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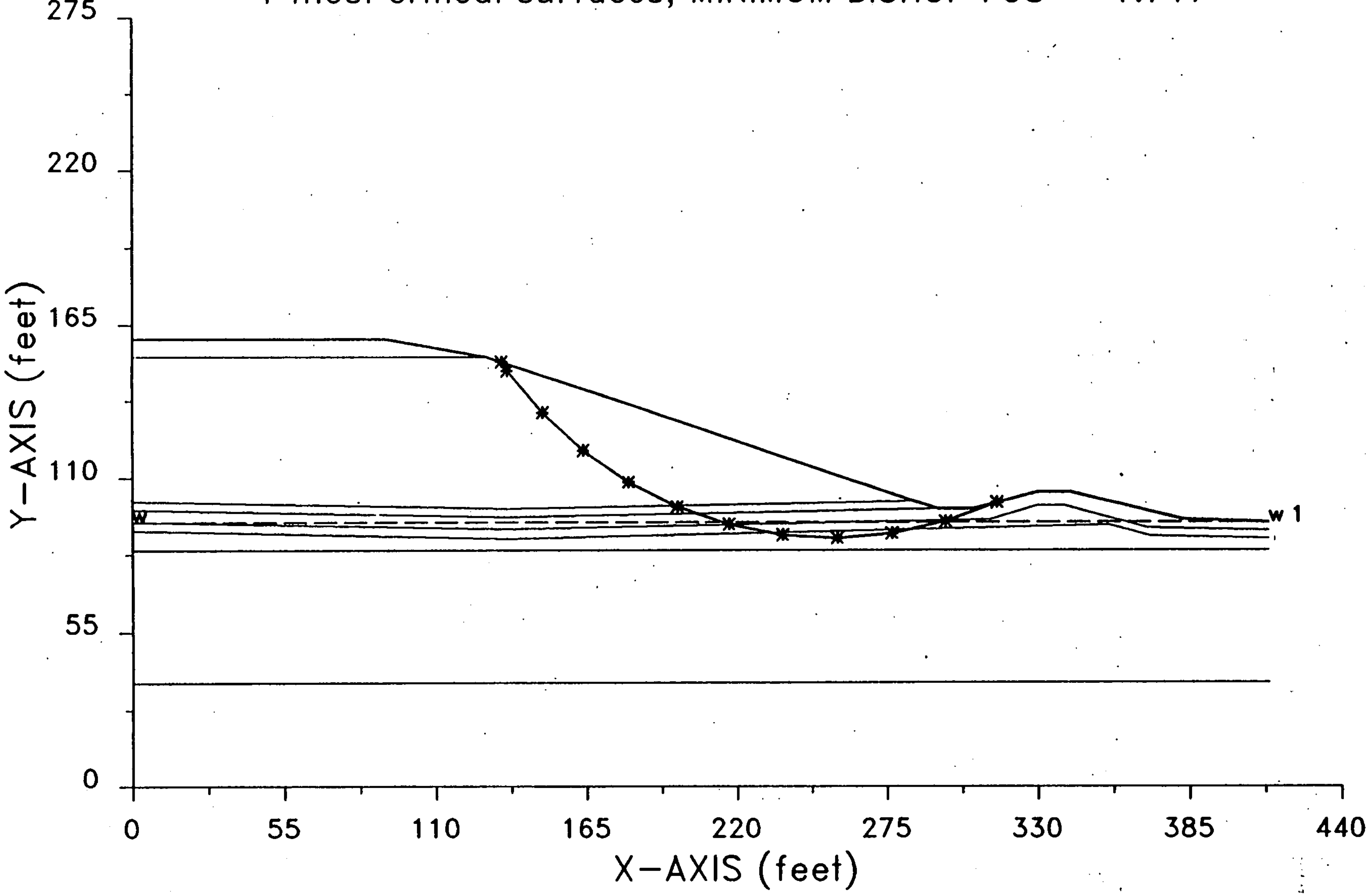
OSDF Interim, long - unit wt 129pcf

1 most critical surfaces, MINIMUM BISHOP FOS = 1.717



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****
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*
* Slope Stability Analysis *
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* Method of Slices *
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****

Problem Description : OSDF Interim, long - unit wt 129pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Constant (psf)	Water Surface No.
1	129.0	129.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	.0	25.00	.000	.0	0
4	135.0	135.0	.0	25.00	.000	.0	1
5	145.0	145.0	.0	30.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 2 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	94.00
2	414.00	94.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 100 points equally spaced along the ground surface between x = 280.0 ft
and x = 330.0 ft

Each surface terminates between x = 80.0 ft
and x = 150.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

20.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS :

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The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := -20.0 degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	315.35	101.18
2	296.59	94.26
3	277.06	89.95
4	257.12	88.33
5	237.15	89.42
6	217.52	93.21
7	198.58	99.63
8	180.68	108.56
9	164.16	119.84
10	149.32	133.24
11	136.44	148.54
12	134.37	151.81

**** Simplified BISHOP FOS = 1.717 ****

The following is a summary of the TEN most critical surfaces

Problem Description : OSDF Interim, long - unit wt 129pcf

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.717	255.18	235.48	147.16	315.35	134.37	3.156E+07
2.	1.724	256.15	239.03	150.80	319.90	133.28	3.285E+07
3.	1.728	261.32	228.70	139.45	320.91	148.70	2.471E+07
4.	1.731	254.62	246.64	158.63	321.41	125.80	3.760E+07
5.	1.734	255.67	247.23	159.29	324.44	126.62	3.744E+07
6.	1.735	253.96	243.23	156.23	323.43	125.77	3.831E+07
7.	1.736	254.27	252.04	164.23	324.44	122.26	4.079E+07
8.	1.737	257.83	236.59	148.90	324.95	136.26	3.199E+07
9.	1.737	254.04	256.02	167.85	323.94	120.26	4.211E+07
10.	1.737	252.00	217.40	131.65	312.32	138.82	2.956E+07

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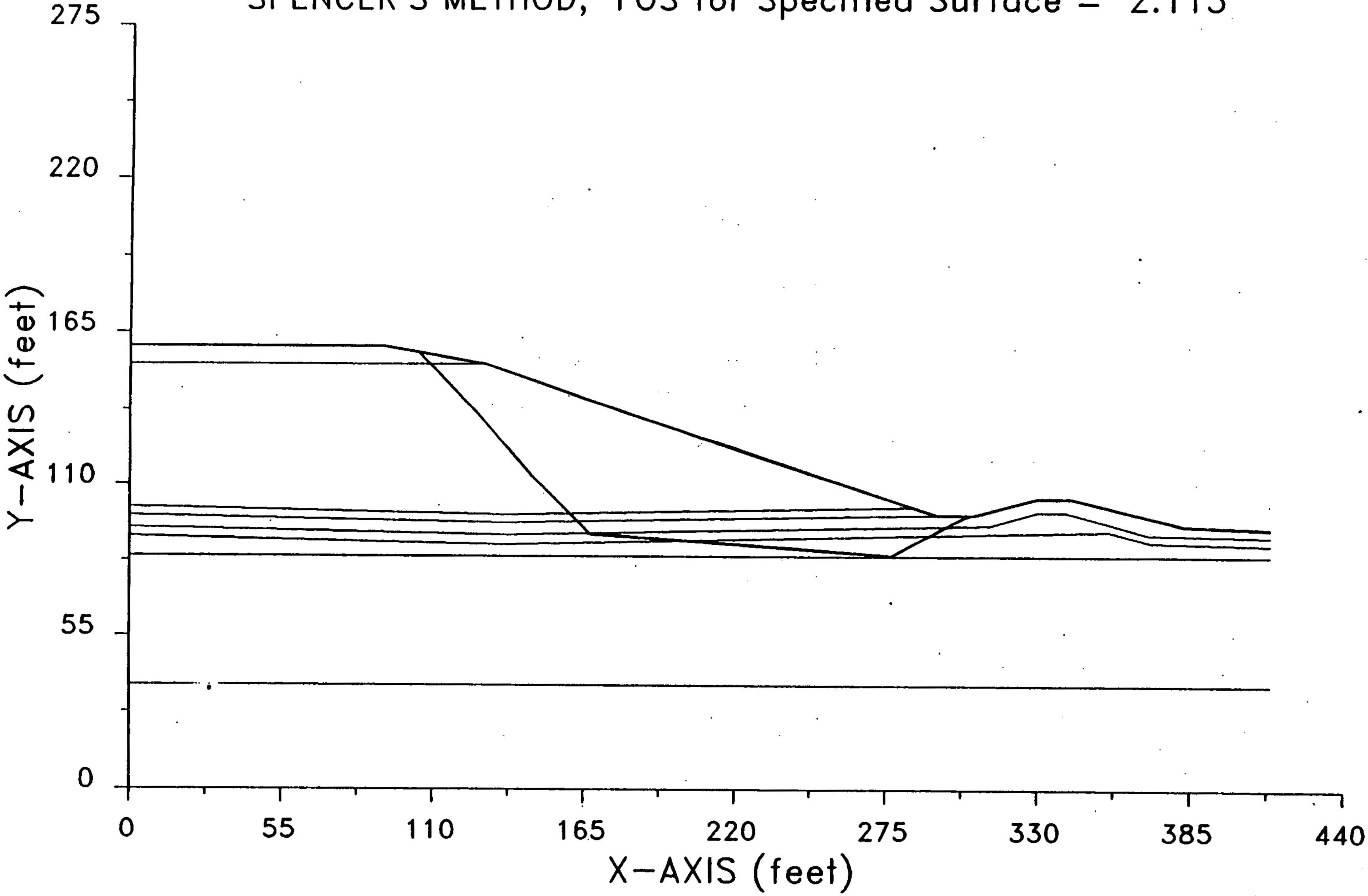
OSDF Interim, long - unit wt 129pcf

SPENCER'S METHOD, FOS for Specified Surface = 2.115



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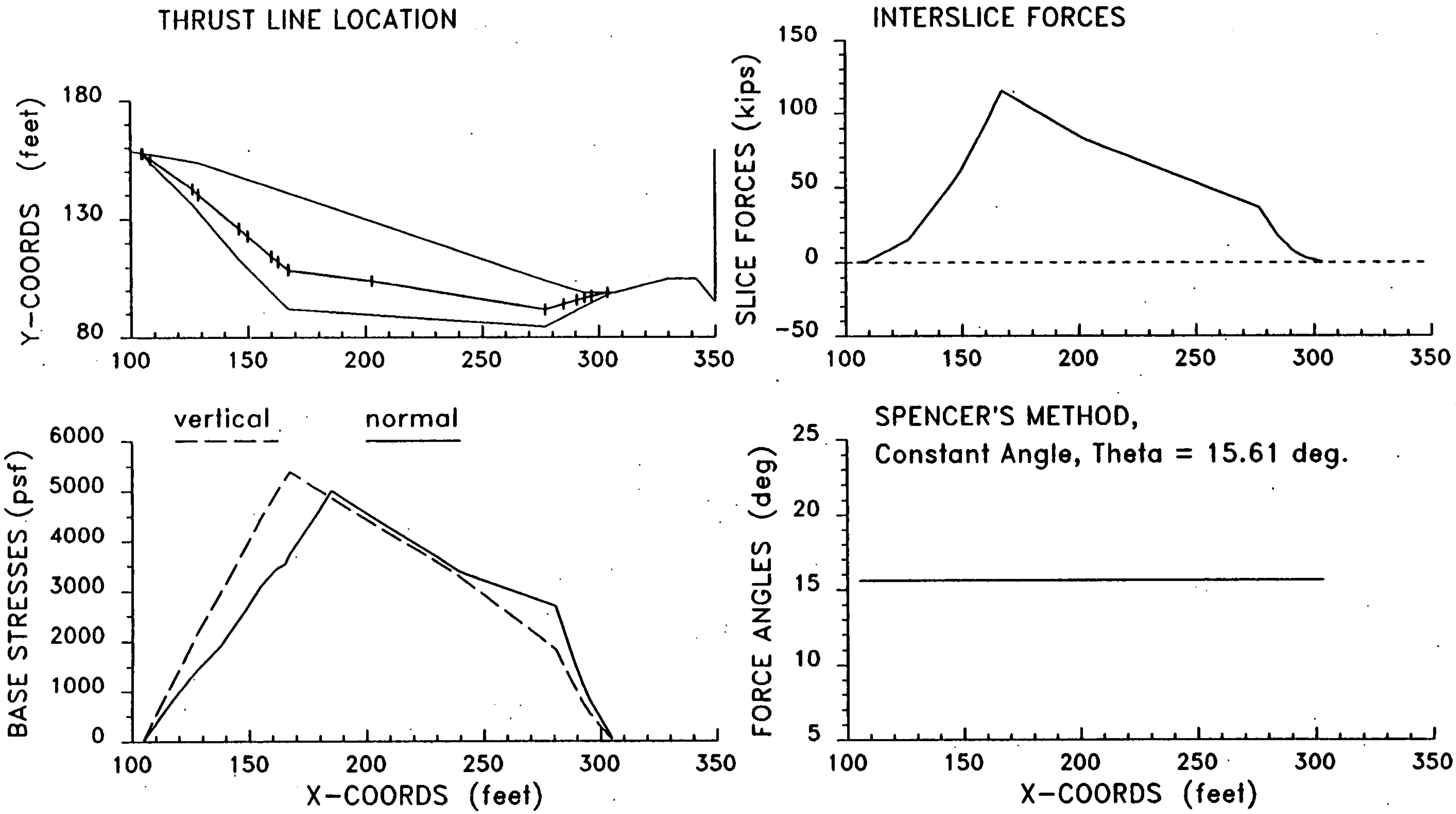

OSDF Interim, long - unit wt 129pcf
SPENCER'S METHOD, FOS for Specified Surface = 2.115

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XSTABL File: CASE2C1 1-27-97 15:14

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*                 X S T A B L               *
*                                           *
*          Slope Stability Analysis         *
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*              Method of Slices             *
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*********************************************
```

Problem Description : OSDF Interim, long - unit wt 129pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

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ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	129.0	129.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	.0	25.00	.000	.0	0
4	135.0	135.0	.0	25.00	.000	.0	0
5	145.0	145.0	.0	30.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 8 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	305.93	99.00
2	303.70	98.21
3	277.07	84.41
4	167.39	91.95
5	146.24	113.22
6	126.47	135.78
7	105.25	157.00
8	104.83	157.78

MHG 27 Jan 97

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	304.82	98.60	.40	2.23	-19.51	.00	110.
2	300.29	96.45	2.55	6.81	-27.39	.00	2175.
3	295.44	93.93	5.07	2.89	-27.39	.00	1841.
4	292.39	92.35	7.12	3.22	-27.39	16.11	2901.
5	287.89	90.02	10.75	5.78	-27.39	16.11	7936.
6	281.04	86.46	16.46	7.93	-27.39	18.43	16950.
7	239.96	86.96	29.65	74.21	3.93	18.43	284299.
8	185.12	90.73	44.16	35.47	3.93	18.43	201501.
9	167.31	92.03	48.80	.16	45.16	18.43	995.
10	165.09	94.26	47.31	4.29	45.16	18.43	26122.

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11	161.50	97.87	44.89	2.89	45.16	18.43	16744.
12	155.03	104.38	40.54	10.05	45.16	18.43	52577.
13	148.12	111.33	35.90	3.76	45.16	18.43	16872.
14	137.62	123.06	27.67	17.24	48.77	18.43	59629.
15	127.73	134.34	19.48	2.53	48.77	9.81	6356.
16	117.56	144.69	10.89	17.82	45.00	9.81	24890.
17	106.95	155.30	2.11	3.40	45.00	9.81	898.
18	105.04	157.39	.35	.42	61.72	9.81	19.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	15.5813	2.1148	2.1321
3	15.6070	2.1154	2.1148

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	67.8	.0	30.00	0.	0.	0.	.00
2	500.9	.0	30.00	0.	0.	0.	.00
3	937.7	.0	25.00	0.	0.	0.	.00
4	1325.7	.0	25.00	0.	0.	0.	.00
5	2021.0	.0	25.00	0.	0.	0.	.00
6	3145.9	.0	25.00	0.	0.	0.	.00
7	3938.2	.0	25.00	0.	0.	0.	.00
8	5839.9	.0	25.00	0.	0.	0.	.00
9	4356.4	.0	25.00	0.	0.	0.	.00
10	4119.7	.0	30.00	0.	0.	0.	.00
11	4018.8	.0	25.00	0.	0.	0.	.00
12	3629.2	.0	25.00	0.	0.	0.	.00
13	3033.6	.0	30.00	0.	0.	0.	.00
14	2225.8	.0	30.00	0.	0.	0.	.00
15	1665.2	.0	25.00	0.	0.	0.	.00
16	971.2	.0	25.00	0.	0.	0.	.00
17	179.0	.0	30.00	0.	0.	0.	.00
18	23.7	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	304.82	67.8	49.4	.0	18.5
2	300.29	500.9	319.3	.0	136.7
3	295.44	937.7	637.1	.0	206.7
4	292.39	1325.7	900.8	.0	292.2
5	287.89	2021.0	1373.1	.0	445.5
6	281.04	3145.9	2137.5	.0	693.5
7	239.96	3938.2	3831.0	.0	868.1
8	185.12	5839.9	5680.9	.0	1287.3
9	167.31	4356.4	6277.7	.0	960.3
10	165.09	4119.7	6093.6	.0	1124.4
11	161.50	4018.8	5791.1	.0	885.9
12	155.03	3629.2	5229.8	.0	800.0
13	148.12	3033.6	4487.2	.0	827.9
14	137.62	2225.8	3458.8	.0	607.5
15	127.73	1665.2	2512.3	.0	367.1

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
16	117.56	971.2	1396.7	.0	214.1
17	106.95	179.0	264.3	.0	48.9
18	105.04	23.7	44.3	.0	6.5

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	303.70	15.61	98.	.71	.79	.895
2	296.89	15.61	2901.	2.83	4.32	.656
3	294.00	15.61	4978.	3.48	5.82	.598
4	290.78	15.61	8253.	4.16	8.42	.494
5	285.00	15.61	17211.	5.41	13.08	.413
6	277.07	15.61	36343.	7.22	19.83	.364
7	202.86	15.61	82372.	14.47	39.47	.367
8	167.39	15.61	114995.	16.79	48.85	.344
9	167.23	15.61	114432.	16.76	48.75	.344
10	162.94	15.61	100996.	15.67	45.86	.342
11	160.05	15.61	91523.	15.08	43.92	.343
12	150.00	15.61	61776.	13.29	37.16	.358
13	146.24	15.61	53098.	12.51	34.63	.361
14	129.00	15.61	18508.	7.16	20.71	.346
15	126.47	15.61	14481.	6.67	18.26	.365
16	108.65	15.61	473.	1.28	3.52	.363
17	105.25	15.61	13.	.33	.71	.469
18	104.83	.00	-3.	-.37	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 3233.83 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 736.33 (psf)

Total Length of failure surface = 233.19 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 2.115

Total shear strength available
along specified failure surface = 363.22E+03 lb

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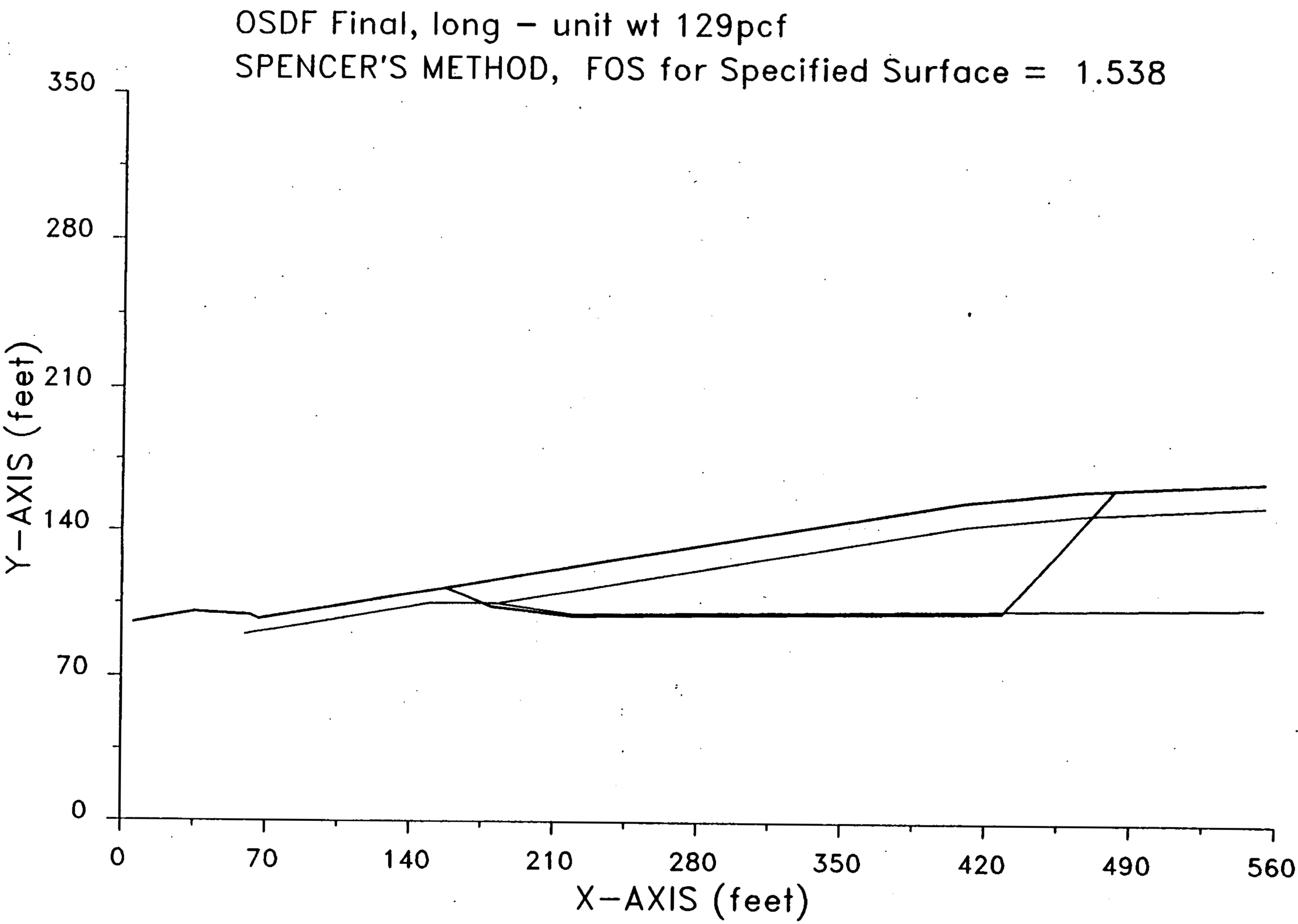

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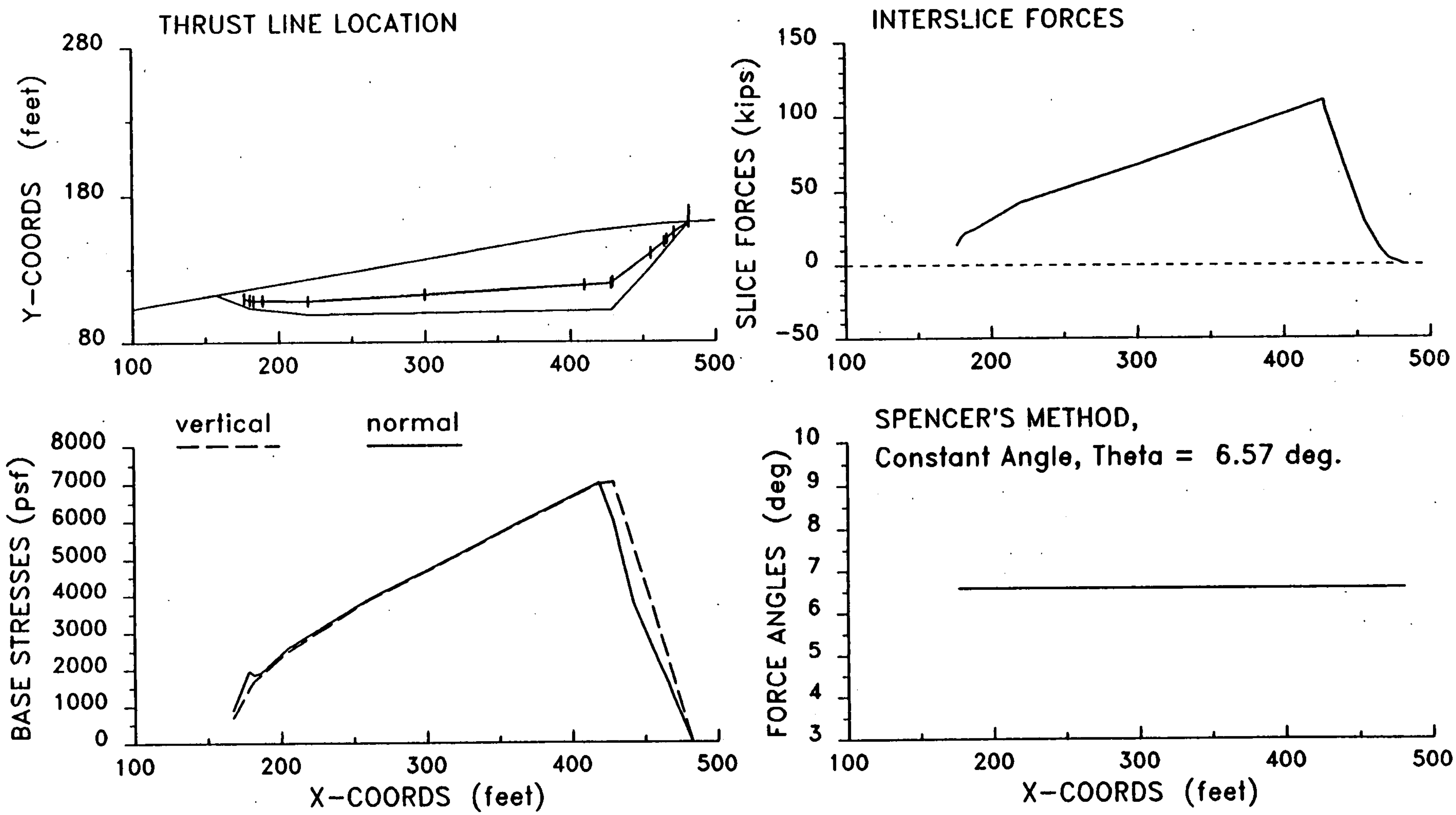

OSDF Final, long - unit wt 129pcf

SPENCER'S METHOD, FOS for Specified Surface = 1.538

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*******************************************
*               X S T A B L               *
*                                         *
*        Slope Stability Analysis         *
*               using the                 *
*           Method of Slices              *
*                                         *
*        Copyright (C) 1992 - 94          *
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Problem Description : OSDF Final, long - unit wt 129pcf

SEGMENT BOUNDARY COORDINATES

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6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	5.5	95.6	35.5	100.6	2
2	35.5	100.6	62.5	99.3	2
3	62.5	99.3	67.0	97.5	2
4	67.0	97.5	410.0	154.7	2
5	410.0	154.7	465.0	160.2	2
6	465.0	160.2	555.0	164.7	2

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	60.0	90.0	120.0	100.0	2
2	120.0	100.0	150.0	105.0	2
3	150.0	105.0	183.0	105.0	2
4	183.0	105.0	189.0	106.0	1
5	189.0	106.0	410.0	142.8	1
6	410.0	142.8	467.0	148.5	1
7	467.0	148.5	555.0	152.9	1
8	183.0	105.0	220.0	100.0	6
9	220.0	100.0	300.0	100.8	5
10	300.0	100.8	410.0	102.0	4
11	410.0	102.0	555.0	103.5	3

ISOTROPIC Soil Parameters

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6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	129.0	129.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	125.0	125.0	.0	5.00	.000	.0	0
4	125.0	125.0	.0	6.00	.000	.0	0
5	125.0	125.0	.0	8.00	.000	.0	0
6	125.0	125.0	.0	10.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 7 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	157.53	112.60
2	180.25	103.47
3	220.00	99.00
4	428.25	101.18
5	455.60	130.37
6	481.96	160.45
7	482.22	161.06

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	166.99	108.80	5.38	18.91	-21.89	9.47	12707.
2	178.35	104.24	11.83	3.81	-21.89	9.47	5634.
3	181.63	103.32	13.30	2.75	-6.42	9.47	4572.
4	186.00	102.82	14.52	6.00	-6.42	9.47	10913.
5	204.50	100.74	19.69	31.00	-6.42	9.47	77091.
6	260.00	99.42	30.27	80.00	.60	9.47	308242.
7	355.00	100.41	45.11	110.00	.60	9.47	634515.
8	419.13	101.08	54.53	18.25	.60	5.71	127430.
9	428.73	101.69	54.88	.95	46.86	5.71	6710.
10	442.40	116.28	41.66	26.40	46.86	5.71	140583.
11	460.30	135.73	24.00	9.40	48.77	5.71	28651.
12	466.00	142.24	18.01	2.00	48.77	2.86	4552.
13	469.35	146.06	14.36	4.69	48.77	2.86	8473.
14	476.83	154.59	6.20	10.27	48.77	2.86	7955.
15	482.09	160.76	.30	.26	66.95	2.86	10.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment

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2	6.5518	1.5375	1.5666
3	6.5749	1.5379	1.5375

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	884.6	.0	30.00	0.	0.	0.	.00
2	1947.3	.0	30.00	0.	0.	0.	.00
3	1844.0	.0	30.00	0.	0.	0.	.00
4	1892.8	.0	10.00	0.	0.	0.	.00
5	2587.9	.0	10.00	0.	0.	0.	.00
6	3885.6	.0	8.00	0.	0.	0.	.00
7	5802.9	.0	6.00	0.	0.	0.	.00
8	7015.8	.0	5.00	0.	0.	0.	.00
9	5972.2	.0	5.00	0.	0.	0.	.00
10	3772.8	.0	25.00	0.	0.	0.	.00
11	2112.9	.0	25.00	0.	0.	0.	.00
12	1577.9	.0	25.00	0.	0.	0.	.00
13	1251.4	.0	25.00	0.	0.	0.	.00
14	510.9	.0	30.00	0.	0.	0.	.00
15	18.2	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	166.99	884.6	671.9	.0	332.1
2	178.35	1947.3	1479.2	.0	731.1
3	181.63	1844.0	1662.5	.0	692.3
4	186.00	1892.8	1818.8	.0	217.0
5	204.50	2587.9	2486.8	.0	296.7
6	260.00	3885.6	3853.0	.0	355.1
7	355.00	5802.9	5768.3	.0	396.6
8	419.13	7015.8	6982.5	.0	399.1
9	428.73	5972.2	7030.3	.0	339.8
10	442.40	3772.8	5326.0	.0	1144.0
11	460.30	2112.9	3048.0	.0	640.7
12	466.00	1577.9	2276.2	.0	478.4
13	469.35	1251.4	1805.3	.0	379.5
14	476.83	510.9	774.9	.0	191.8
15	482.09	18.2	37.4	.0	6.8

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	176.44	6.57	13087.	4.89	10.75	.455
2	180.25	6.57	18888.	5.06	12.92	.392
3	183.00	6.57	21379.	5.06	13.68	.370
4	189.00	6.57	23975.	5.81	15.36	.378
5	220.00	6.57	42316.	8.83	24.01	.368
6	300.00	6.57	67636.	12.36	36.52	.339
7	410.00	6.57	104824.	17.50	53.71	.326
8	428.25	6.57	110807.	18.42	55.35	.333
9	429.20	6.57	105010.	18.50	54.42	.340
10	455.60	6.57	28417.	9.40	28.89	.325
11	465.00	6.57	11666.	6.34	19.10	.332
12	467.00	6.57	9004.	5.86	16.92	.346
13	471.69	6.57	4050.	5.28	11.80	.447
14	481.96	6.57	7.	.28	.60	.473
15	482.22	.00	-2.	7.74	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 3979.35 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 459.79 (psf)

Total Length of failure surface = 353.41 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.538

Total shear strength available along specified failure surface = 249.89E+03 lb

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XSTABL Analyses

Impacted Material Unit Weight = 143 pcf

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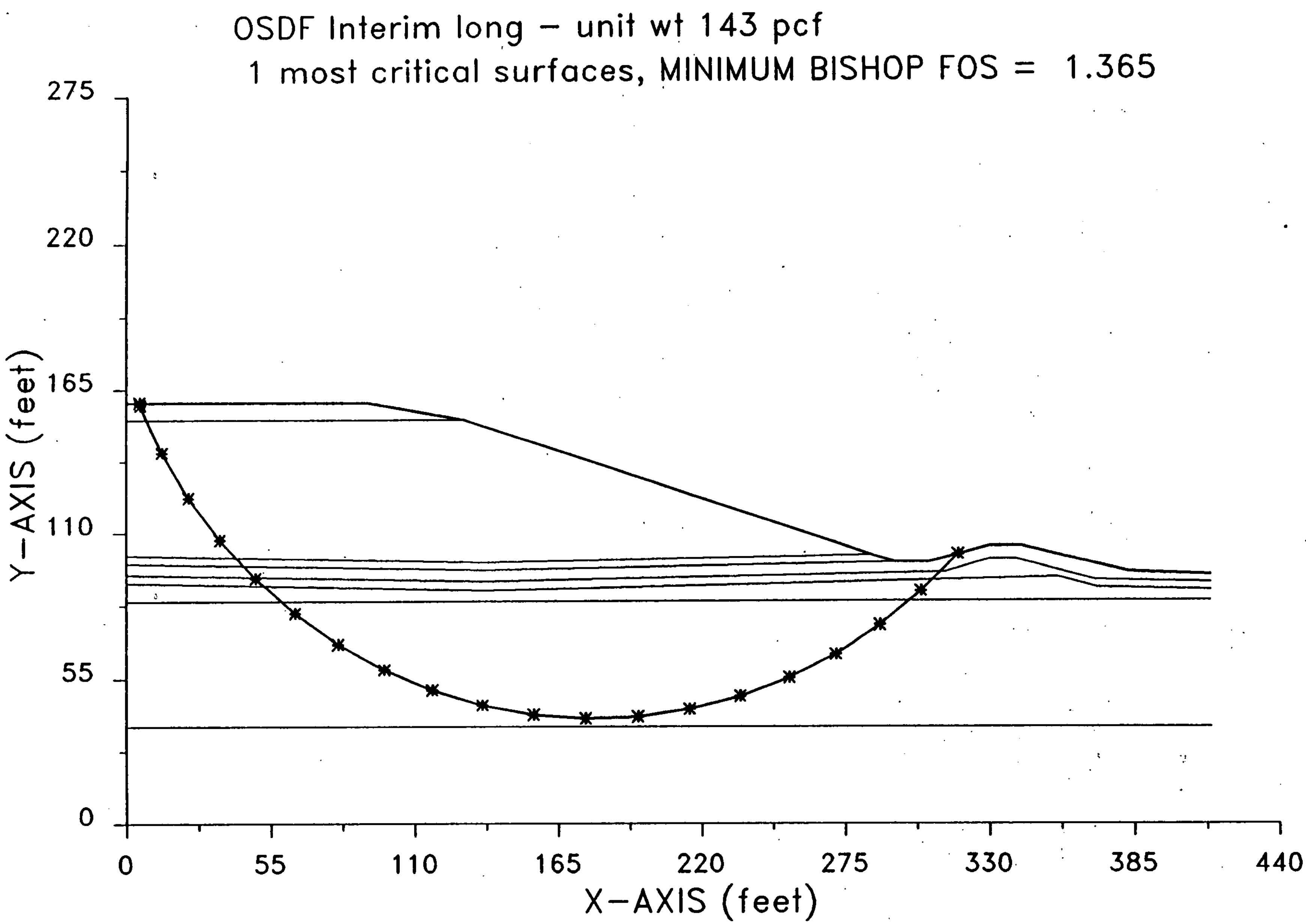

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*******************************************
*                X S T A B L              *
*                                         *
*         Slope Stability Analysis        *
*                using the                *
*            Method of Slices             *
*                                         *
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Problem Description : OSDF Interim long - unit wt 143 pcf

SEGMENT BOUNDARY COORDINATES

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10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

ISOTROPIC Soil Parameters

---

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	200.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	1200.0	.00	.000	.0	0
4	135.0	135.0	1200.0	.00	.000	.0	0
5	145.0	145.0	1900.0	.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced along the ground surface between x = 318.0 ft and x = 348.0 ft

Each surface terminates between x = 5.0 ft and x = 30.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

20.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 21 coordinate points

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Point No.	x-surf (ft)	y-surf (ft)
1	318.00	101.87
2	303.85	87.74
3	288.26	75.20
4	271.42	64.41
5	253.53	55.48
6	234.78	48.52
7	215.39	43.60
8	195.59	40.79
9	175.60	40.11
10	155.66	41.58
11	135.98	45.18
12	116.81	50.86
13	98.35	58.56
14	80.82	68.19
15	64.42	79.64
16	49.35	92.78
17	35.76	107.46
18	23.83	123.51
19	13.68	140.75
20	5.44	158.97
21	5.10	160.00

**** Simplified BISHOP FOS = 1.365 ****

The following is a summary of the TEN most critical surfaces

Problem Description : OSDF Interim long - unit wt 143 pcf

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.365	179.30	226.64	186.56	318.00	5.10	1.254E+08
2.	1.366	180.58	228.38	187.67	319.58	5.87	1.261E+08
3.	1.367	180.68	229.24	189.07	321.16	4.94	1.282E+08
4.	1.367	181.71	229.38	188.40	321.16	6.64	1.267E+08
5.	1.368	188.60	217.14	173.29	318.00	25.01	1.096E+08
6.	1.368	182.20	229.79	189.21	322.74	6.52	1.281E+08
7.	1.368	182.98	229.96	188.75	322.74	7.77	1.271E+08
8.	1.369	185.14	223.29	180.87	319.58	16.00	1.183E+08
9.	1.369	187.89	220.23	175.89	318.00	22.69	1.117E+08
10.	1.370	189.04	220.34	176.01	319.58	23.79	1.119E+08

• • • END OF FILE • • •

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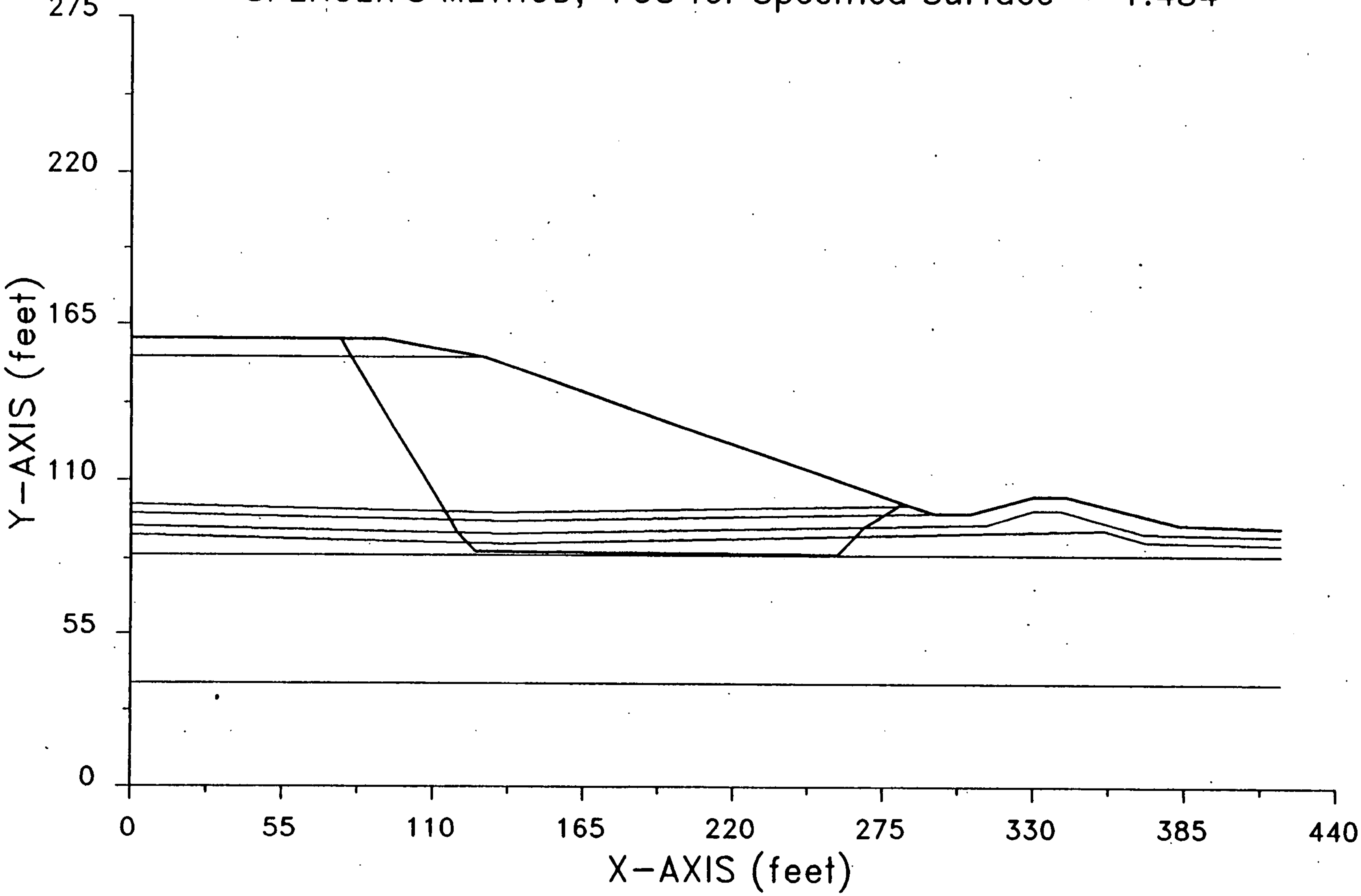
OSDF Interim short - unit wt 143pcf

SPENCER'S METHOD, FOS for Specified Surface = 1.484



MH 27 Jan 97

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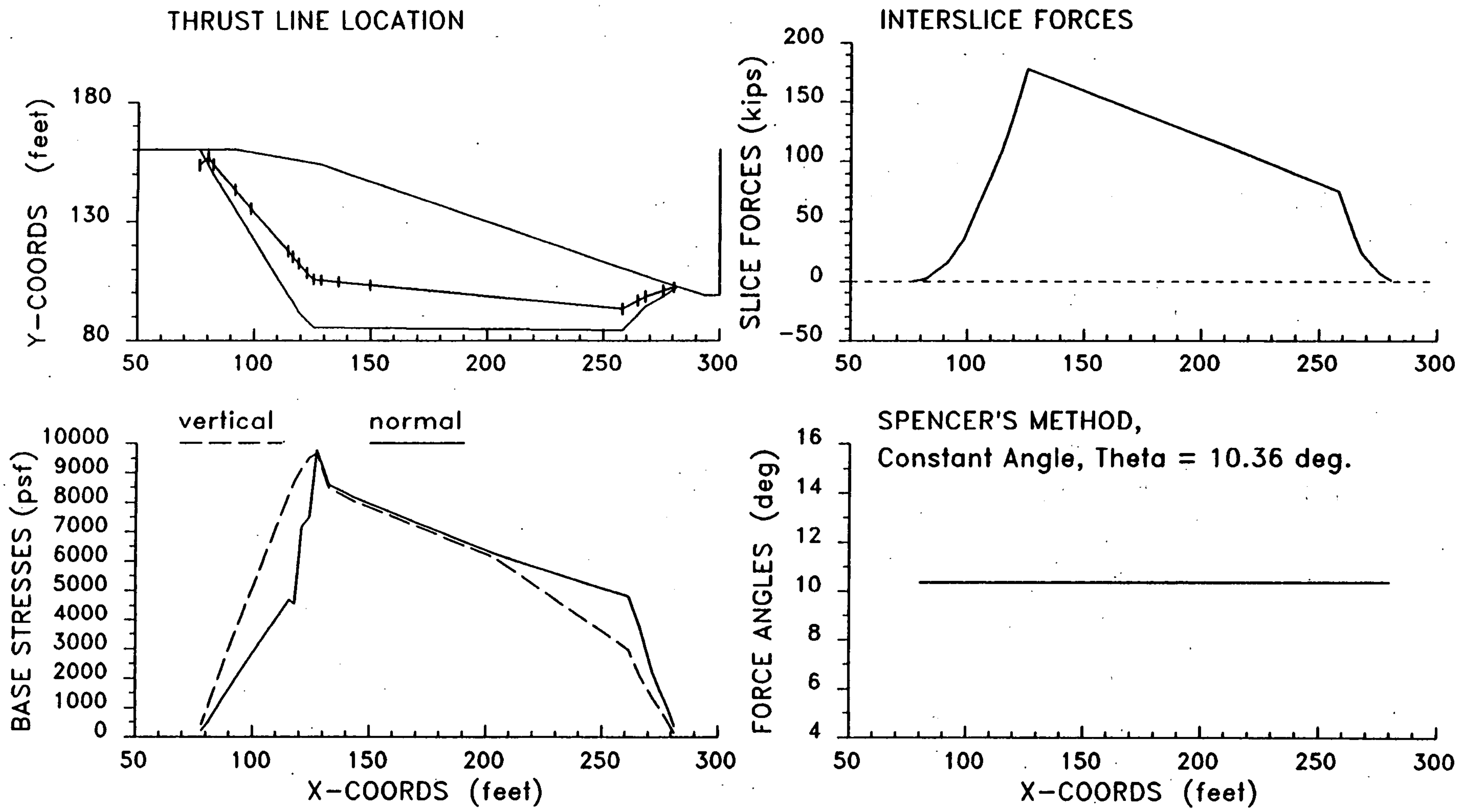

OSDF Interim short – unit wt 143pcf

SPENCER'S METHOD, FOS for Specified Surface = 1.484

MWH 27 Jun 97

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*********************************************
*                 X S T A B L               *
*                                           *
*         Slope Stability Analysis          *
*                 using the                 *
*             Method of Slices              *
*                                           *
*          Copyright (C) 1992 - 94          *
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*  Ver. 5.100                  95 - 1305    *
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Problem Description : OSDF Interim short - unit wt 143pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	420.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	420.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	420.0	88.0	4
16	.0	84.0	420.0	84.0	5
17	.0	37.0	420.0	37.0	6

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	200.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	1200.0	.00	.000	.0	0
4	135.0	135.0	1200.0	.00	.000	.0	0
5	145.0	145.0	1900.0	.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 15 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	282.15	102.55
2	280.52	101.52
3	276.01	98.65
4	268.16	94.11
5	264.98	90.93
6	258.41	84.36
7	125.76	85.38
8	122.84	88.30
9	119.30	91.84
10	116.73	96.29
11	114.80	99.33
12	98.68	124.63
13	82.56	149.93
14	80.22	153.60
15	76.53	160.00

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*******************************************************
SELECTED METHOD OF ANALYSIS:  Spencer (1973)
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*******************************************
SUMMARY OF INDIVIDUAL SLICE INFORMATION
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Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	281.33	102.03	.79	1.63	-32.29	18.43	184.
2	278.26	100.08	3.76	4.51	-32.47	18.43	2424.
3	276.01	98.65	5.95	.01	-30.04	18.43	6.

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4	272.08	96.38	9.53	7.84	-30.04	18.43	10377.
5	266.57	92.52	15.23	3.18	-45.00	18.43	6616.
6	261.69	87.64	21.73	6.57	-45.00	18.43	19447.
7	204.21	84.78	43.75	108.41	.44	18.43	660965.
8	143.25	85.25	63.60	13.50	.44	18.43	108687.
9	132.75	85.33	67.02	7.50	.44	18.43	63577.
10	127.38	85.37	68.51	3.24	.44	9.81	31250.
11	124.30	86.84	67.57	2.92	45.00	9.81	27779.
12	121.07	90.07	64.90	3.54	45.00	9.81	32407.
13	118.01	94.07	61.43	2.57	59.99	9.81	22392.
14	115.76	97.81	58.08	1.93	57.59	9.81	15944.
15	106.74	111.98	45.47	16.12	57.50	9.81	103699.
16	95.34	129.87	29.55	6.68	57.50	9.81	27527.
17	87.28	142.52	17.48	9.44	57.50	.00	22506.
18	81.39	151.76	8.24	2.34	57.48	.00	2486.
19	78.38	156.80	3.20	3.69	60.03	.00	1476.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	10.0317	1.4751	1.6411
3	10.3743	-----	1.4751
3	10.2030	1.4795	-----
4	10.3648	1.4837	1.4795
5	10.3603	1.4836	1.4837

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	354.0	200.0	25.00	0.	0.	0.	.00
2	1035.3	200.0	25.00	0.	0.	0.	.00
3	1455.6	200.0	25.00	0.	0.	0.	.00
4	2212.4	.0	30.00	0.	0.	0.	.00
5	3713.8	1200.0	.00	0.	0.	0.	.00
6	4794.8	1200.0	.00	0.	0.	0.	.00
7	6229.8	1200.0	.00	0.	0.	0.	.00
8	8181.0	1200.0	.00	0.	0.	0.	.00
9	8606.5	1200.0	.00	0.	0.	0.	.00
10	9773.1	1200.0	.00	0.	0.	0.	.00
11	7483.4	1200.0	.00	0.	0.	0.	.00
12	7180.7	1200.0	.00	0.	0.	0.	.00
13	4538.9	.0	30.00	0.	0.	0.	.00
14	4680.4	200.0	25.00	0.	0.	0.	.00
15	3625.6	200.0	25.00	0.	0.	0.	.00
16	2283.5	200.0	25.00	0.	0.	0.	.00
17	1275.4	200.0	25.00	0.	0.	0.	.00
18	508.4	200.0	25.00	0.	0.	0.	.00
19	208.3	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	281.33	354.0	112.7	.0	246.1
2	278.26	1035.3	537.8	.0	460.2
3	276.01	1455.6	850.9	.0	592.3

4	272.08	2212.4	1323.1	.0	860.9
5	266.57	3713.8	2078.1	.0	808.8
6	261.69	4794.8	2961.5	.0	808.8
7	204.21	6229.8	6096.9	.0	808.8
8	143.25	8181.0	8050.9	.0	808.8
9	132.75	8606.5	8477.0	.0	808.8
10	127.38	9773.1	9645.2	.0	808.8
11	124.30	7483.4	9512.5	.0	808.8
12	121.07	7180.7	9154.5	.0	808.8
13	118.01	4538.9	8711.3	.0	1766.3
14	115.76	4680.4	8264.1	.0	1605.9
15	106.74	3625.6	6433.0	.0	1274.4
16	95.34	2283.5	4120.9	.0	852.5
17	87.28	1275.4	2384.1	.0	535.7
18	81.39	508.4	1062.4	.0	294.6
19	78.38	208.3	400.0	.0	81.0

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	280.52	10.36	780.	.66	1.58	.422
2	276.01	10.36	5907.	2.18	5.95	.366
3	276.00	10.36	5918.	2.18	5.95	.366
4	268.16	10.36	22983.	4.31	13.10	.329
5	264.98	10.36	37619.	5.67	17.35	.327
6	258.41	10.36	75026.	8.67	26.10	.332
7	150.00	10.36	158886.	18.06	61.41	.294
8	136.50	10.36	169123.	19.26	65.80	.293
9	129.00	10.36	174786.	19.93	68.24	.292
10	125.76	10.36	177202.	20.22	68.78	.294
11	122.84	10.36	157388.	20.23	66.37	.305
12	119.30	10.36	134458.	20.54	63.44	.324
13	116.73	10.36	118536.	19.05	59.43	.321
14	114.80	10.36	107227.	18.23	56.73	.321
15	98.68	10.36	34862.	10.52	34.21	.308
16	92.00	10.36	16314.	7.96	24.89	.320
17	82.56	10.36	2246.	3.72	10.07	.369
18	80.22	10.36	1050.	2.86	6.40	.447
19	76.53	.00	-1.	-6.59	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 4912.52 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 838.18 (psf)

Total Length of failure surface = 252.40 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.484

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Total shear strength available
along specified failure surface = 313.87E+03 lb

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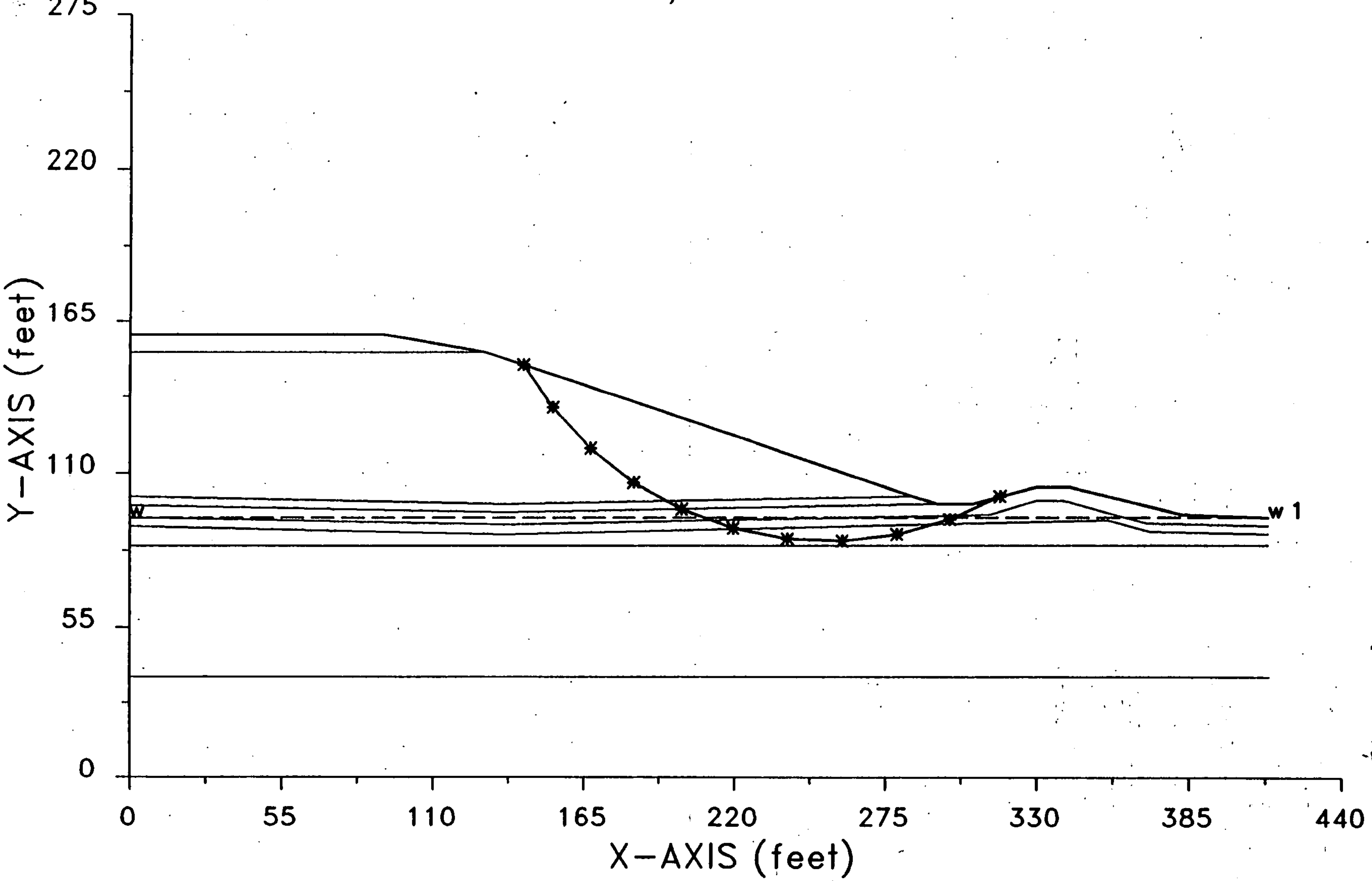
OSDF Interim, long - unit wt 143pcf

1 most critical surfaces, MINIMUM JANBU FOS = 1.598



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*******************************************
*                X S T A B L              *
*                                         *
*        Slope Stability Analysis         *
*               using the                 *
*           Method of Slices              *
*                                         *
*       Copyright (C) 1992 - 94           *
*   Interactive Software Designs, Inc.    *
*       Moscow, ID 83843, U.S.A.          *
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*                                         *
*  Ver. 5.100                 95 - 1305   *
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```

Problem Description : OSDF Interim, long - unit wt 143pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	.0	25.00	.000	.0	0
4	135.0	135.0	.0	25.00	.000	.0	1
5	145.0	145.0	.0	30.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

1 Water surface(s) have been specified

Unit weight of water =   62.40 (pcf)

Water Surface No. 1 specified by 2 coordinate points

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**********************************
        PHREATIC SURFACE,
**********************************
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Point No.	x-water (ft)	y-water (ft)
1	.00	94.00
2	414.00	94.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

1000 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 100 points equally spaced along the ground surface between x = 280.0 ft and x = 330.0 ft

Each surface terminates between x = 80.0 ft and x = 150.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

20.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS :

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The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := -20.0 degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED JANBU METHOD * * * * *

The 10 most critical of all the failure surfaces examined are displayed below - the most critical first

Failure surface No. 1 specified by 11 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	316.87	101.57
2	298.65	93.32
3	279.38	87.96
4	259.52	85.64
5	239.53	86.40
6	219.90	90.22
7	201.09	97.02
8	183.56	106.64
9	167.71	118.84
10	153.93	133.33
11	143.16	148.88

** Corrected JANBU FOS = 1.598 ** (Fo factor =1.045)

Failure surface No. 2 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	313.84	100.78
2	295.69	92.38
3	276.46	86.88
4	256.61	84.42
5	236.62	85.07
6	216.98	88.81
7	198.14	95.54
8	180.58	105.10
9	164.70	117.27
10	150.91	131.75
11	139.52	148.19
12	138.42	150.46

** Corrected JANBU FOS = 1.601 ** (Fo factor =1.046)

Failure surface No. 3 specified by 11 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	312.32	100.39
2	293.90	92.60
3	274.51	87.69
4	254.60	85.78
5	234.64	86.90
6	215.07	91.04
7	196.35	98.09
8	178.92	107.90
9	163.18	120.23
10	149.48	134.81
11	138.82	150.33

** Corrected JANBU FOS = 1.602 ** (Fo factor =1.044)

Failure surface No. 4 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	315.86	101.31
2	297.59	93.18
3	278.31	87.84
4	258.46	85.40
5	238.47	85.92
6	218.77	89.39
7	199.80	95.73
8	181.98	104.80
9	165.69	116.40
10	151.29	130.28
11	139.10	146.14
12	136.31	151.16

** Corrected JANBU FOS = 1.608 ** (Fo factor =1.045)

Failure surface No. 5 specified by 11 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	320.91	102.63
2	302.26	95.40
3	282.77	90.92
4	262.84	89.26
5	242.88	90.48
6	223.29	94.54
7	204.49	101.36
8	186.86	110.80
9	170.76	122.67
10	156.52	136.71
11	148.70	147.03

** Corrected JANBU FOS = 1.616 ** (Fo factor =1.042)

Failure surface No. 6 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	315.35	101.18
2	296.59	94.26
3	277.06	89.95
4	257.12	88.33
5	237.15	89.42

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6	217.52	93.21
7	198.58	99.63
8	180.68	108.56
9	164.16	119.84
10	149.32	133.24
11	136.44	148.54
12	134.37	151.81

** Corrected JANBU FOS = 1.617 ** (Fo factor =1.042)

Failure surface No. 7 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	325.45	103.81
2	307.58	94.84
3	288.60	88.54
4	268.91	85.04
5	248.92	84.41
6	229.05	86.68
7	209.71	91.79
8	191.31	99.63
9	174.24	110.05
10	158.85	122.82
11	145.46	137.67
12	136.48	151.11

** Corrected JANBU FOS = 1.623 ** (Fo factor =1.045)

Failure surface No. 8 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	319.90	102.36
2	301.25	95.13
3	281.81	90.43
4	261.92	88.34
5	241.93	88.90
6	222.19	92.10
7	203.04	97.89
8	184.83	106.16
9	167.88	116.76
10	152.47	129.52
11	138.89	144.20
12	133.28	152.17

** Corrected JANBU FOS = 1.627 ** (Fo factor =1.042)

Failure surface No. 9 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	319.39	102.23
2	301.09	94.18
3	281.86	88.69
4	262.05	85.88
5	242.05	85.81
6	222.23	88.46
7	202.95	93.79
8	184.59	101.70
9	167.47	112.05
10	151.92	124.63
11	138.24	139.22
12	127.92	153.79

** Corrected JANBU FOS = 1.629 ** (Fo factor =1.044)

Failure surface No.10 specified by 12 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	324.95	103.68
2	306.53	95.89
3	287.23	90.63
4	267.41	88.01
5	247.41	88.06
6	227.60	90.80
7	208.33	96.17
8	189.96	104.07
9	172.81	114.36
10	157.19	126.86
11	143.39	141.33
12	136.26	151.18

** Corrected JANBU FOS = 1.631 ** (Fo factor =1.043)

The following is a summary of the TEN most critical surfaces

Problem Description : OSDF Interim, long - unit wt 143pcf

	Modified JANBU FOS	Correction Factor	Initial x-coord (ft)	Terminal x-coord (ft)	Available Strength (lb)
1.	1.598	1.045	316.87	143.16	2.312E+05
2.	1.601	1.046	313.84	138.42	2.530E+05
3.	1.602	1.044	312.32	138.82	2.408E+05
4.	1.608	1.045	315.86	136.31	2.511E+05
5.	1.616	1.042	320.91	148.70	1.912E+05
6.	1.617	1.042	315.35	134.37	2.307E+05
7.	1.623	1.045	325.45	136.48	2.564E+05
8.	1.627	1.042	319.90	133.28	2.342E+05
9.	1.629	1.044	319.39	127.92	2.692E+05
10.	1.631	1.043	324.95	136.26	2.309E+05

* * * END OF FILE * * *

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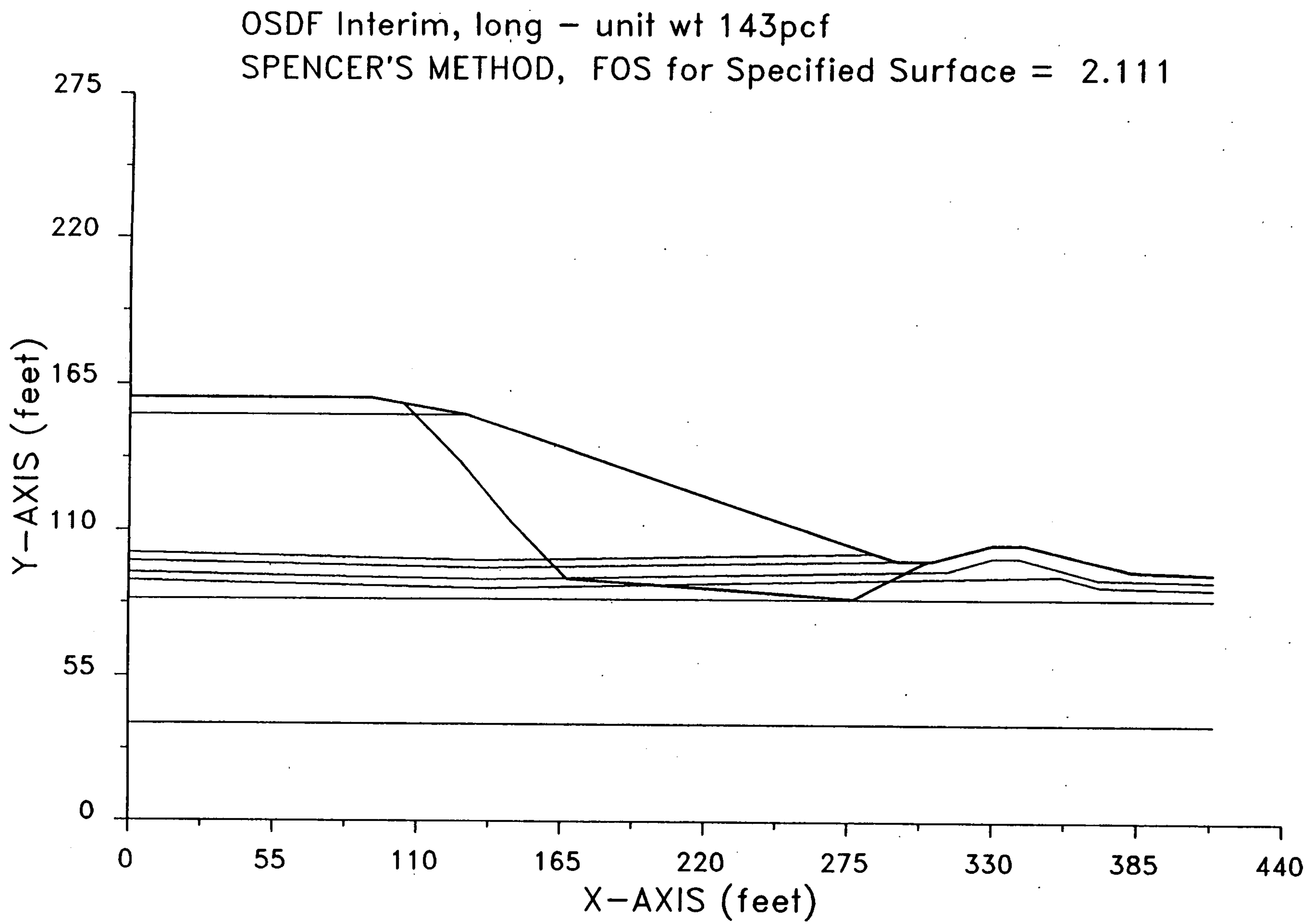

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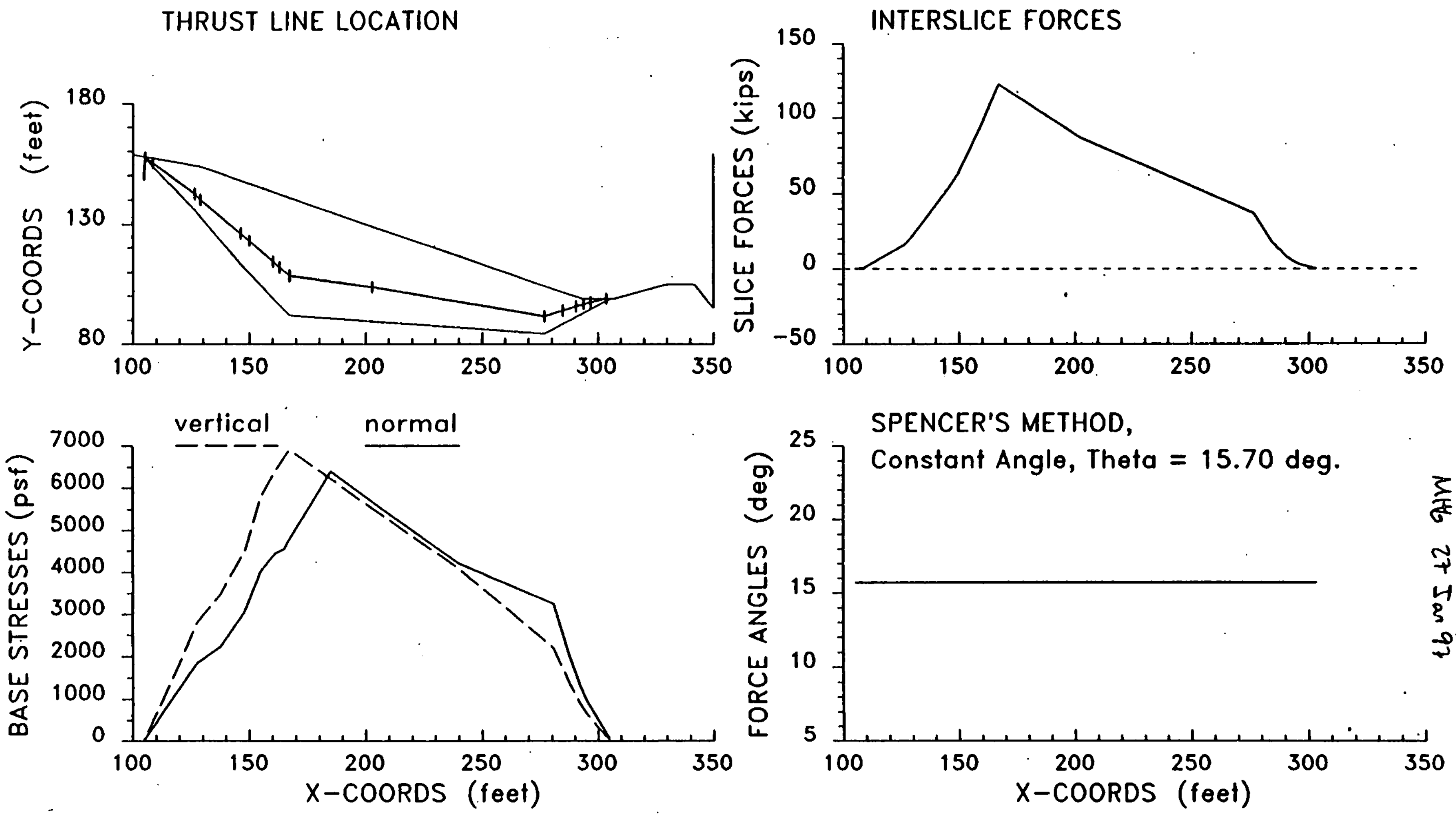

OSDF Interim, long – unit wt 143pcf
SPENCER'S METHOD, FOS for Specified Surface = 2.111

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*********************************************
*                X S T A B L                *
*                                           *
*         Slope Stability Analysis          *
*               using the                   *
*           Method of Slices                *
*                                           *
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* Ver. 5.100                   95 - 1305    *
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Problem Description : OSDF Interim, long - unit wt 143pcf

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

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ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	.0	25.00	.000	.0	0
4	135.0	135.0	.0	25.00	.000	.0	0
5	145.0	145.0	.0	30.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 8 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	305.93	99.00
2	303.70	98.21
3	277.07	84.41
4	167.39	91.95
5	146.24	113.22
6	126.47	135.78
7	105.25	157.00
8	104.83	157.78

MHP 27 Jan 97

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	304.82	98.60	.40	2.23	-19.51	.00	110.
2	300.29	96.45	2.55	6.81	-27.39	.00	2175.
3	295.44	93.93	5.07	2.89	-27.39	.00	1841.
4	292.39	92.35	7.12	3.22	-27.39	16.11	2901.
5	287.89	90.02	10.75	5.78	-27.39	16.11	7936.
6	281.04	86.46	16.46	7.93	-27.39	18.43	17414.
7	239.96	86.96	29.65	74.21	3.93	18.43	303702.
8	185.12	90.73	44.16	35.47	3.93	18.43	220388.
9	167.31	92.03	48.80	.16	45.16	18.43	1093.
10	165.09	94.26	47.31	4.29	45.16	18.43	28829.

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11	161.50	97.87	44.89	2.89	45.16	18.43	18561.
12	155.03	104.38	40.54	10.05	45.16	18.43	58283.
13	148.12	111.33	35.90	3.76	45.16	18.43	16872.
14	137.62	123.06	27.67	17.24	48.77	18.43	59629.
15	127.73	134.34	19.48	2.53	48.77	9.81	7039.
16	117.56	144.69	10.89	17.82	45.00	9.81	27113.
17	106.95	155.30	2.11	3.40	45.00	9.81	898.
18	105.04	157.39	.35	.42	61.72	9.81	19.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	15.6528	2.1095	2.1248
3	15.6986	2.1106	2.1095
4	15.6969	2.1105	2.1106

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	67.9	.0	30.00	0.	0.	0.	.00
2	502.3	.0	30.00	0.	0.	0.	.00
3	940.0	.0	25.00	0.	0.	0.	.00
4	1329.0	.0	25.00	0.	0.	0.	.00
5	2025.9	.0	25.00	0.	0.	0.	.00
6	3239.9	.0	25.00	0.	0.	0.	.00
7	4208.5	.0	25.00	0.	0.	0.	.00
8	6389.6	.0	25.00	0.	0.	0.	.00
9	4781.4	.0	25.00	0.	0.	0.	.00
10	4541.4	.0	30.00	0.	0.	0.	.00
11	4449.7	.0	25.00	0.	0.	0.	.00
12	4018.3	.0	25.00	0.	0.	0.	.00
13	3030.1	.0	30.00	0.	0.	0.	.00
14	2222.9	.0	30.00	0.	0.	0.	.00
15	1841.5	.0	25.00	0.	0.	0.	.00
16	1056.7	.0	25.00	0.	0.	0.	.00
17	178.8	.0	30.00	0.	0.	0.	.00
18	22.7	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	304.82	67.9	49.4	.0	18.6
2	300.29	502.3	319.3	.0	137.4
3	295.44	940.0	637.1	.0	207.7
4	292.39	1329.0	900.8	.0	293.6
5	287.89	2025.9	1373.1	.0	447.6
6	281.04	3239.9	2195.9	.0	715.8
7	239.96	4208.5	4092.5	.0	929.8
8	185.12	6389.6	6213.4	.0	1411.7
9	167.31	4781.4	6898.2	.0	1056.4
10	165.09	4541.4	6725.2	.0	1242.3
11	161.50	4449.7	6419.6	.0	983.1
12	155.03	4018.3	5797.4	.0	887.8
13	148.12	3030.1	4487.2	.0	828.9
14	137.62	2222.9	3458.8	.0	608.1

15	127.73	1841.5	2782.0	.0	406.9
16	117.56	1056.7	1521.5	.0	233.5
17	106.95	178.8	264.3	.0	48.9
18	105.04	22.7	44.3	.0	6.2

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	303.70	15.70	99.	.71	.79	.897
2	296.89	15.70	2913.	2.84	4.32	.657
3	294.00	15.70	4998.	3.48	5.82	.599
4	290.78	15.70	8284.	4.16	8.42	.495
5	285.00	15.70	17274.	5.41	13.08	.414
6	277.07	15.70	37000.	7.18	19.83	.362
7	202.86	15.70	86375.	14.32	39.47	.363
8	167.39	15.70	122205.	16.55	48.85	.339
9	167.23	15.70	121587.	16.52	48.75	.339
10	162.94	15.70	106782.	15.49	45.86	.338
11	160.05	15.70	96295.	14.96	43.92	.341
12	150.00	15.70	63365.	13.56	37.16	.365
13	146.24	15.70	54701.	12.77	34.63	.369
14	129.00	15.70	20165.	7.11	20.71	.343
15	126.47	15.70	15712.	6.64	18.26	.364
16	108.65	15.70	474.	1.27	3.52	.362
17	105.25	15.70	15.	.34	.71	.479
18	104.83	.00	0.	-7.48	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 3462.27 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 789.06 (psf)

Total Length of failure surface = 233.19 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 2.111

Total shear strength available
along specified failure surface = 388.34E+03 lb

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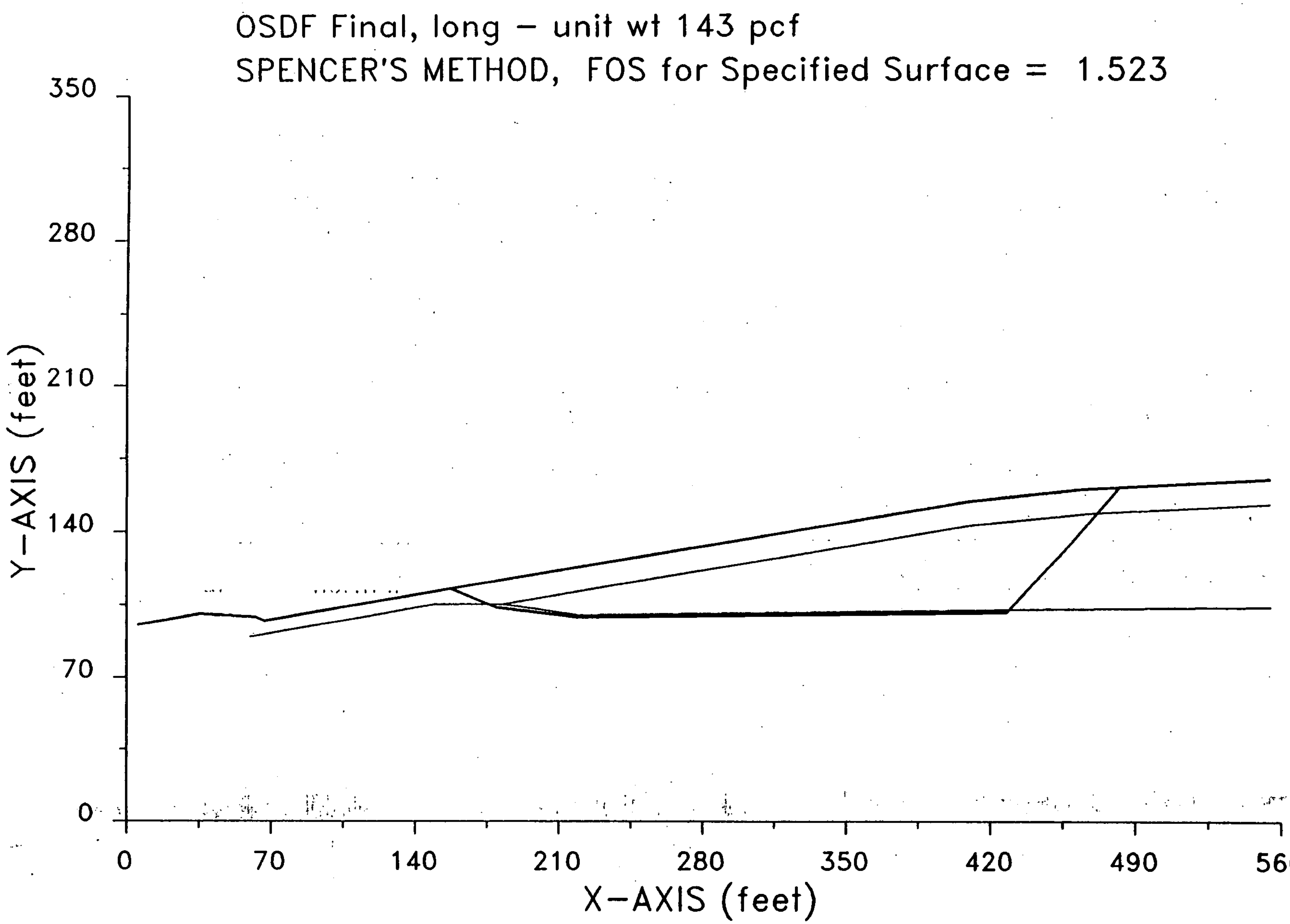

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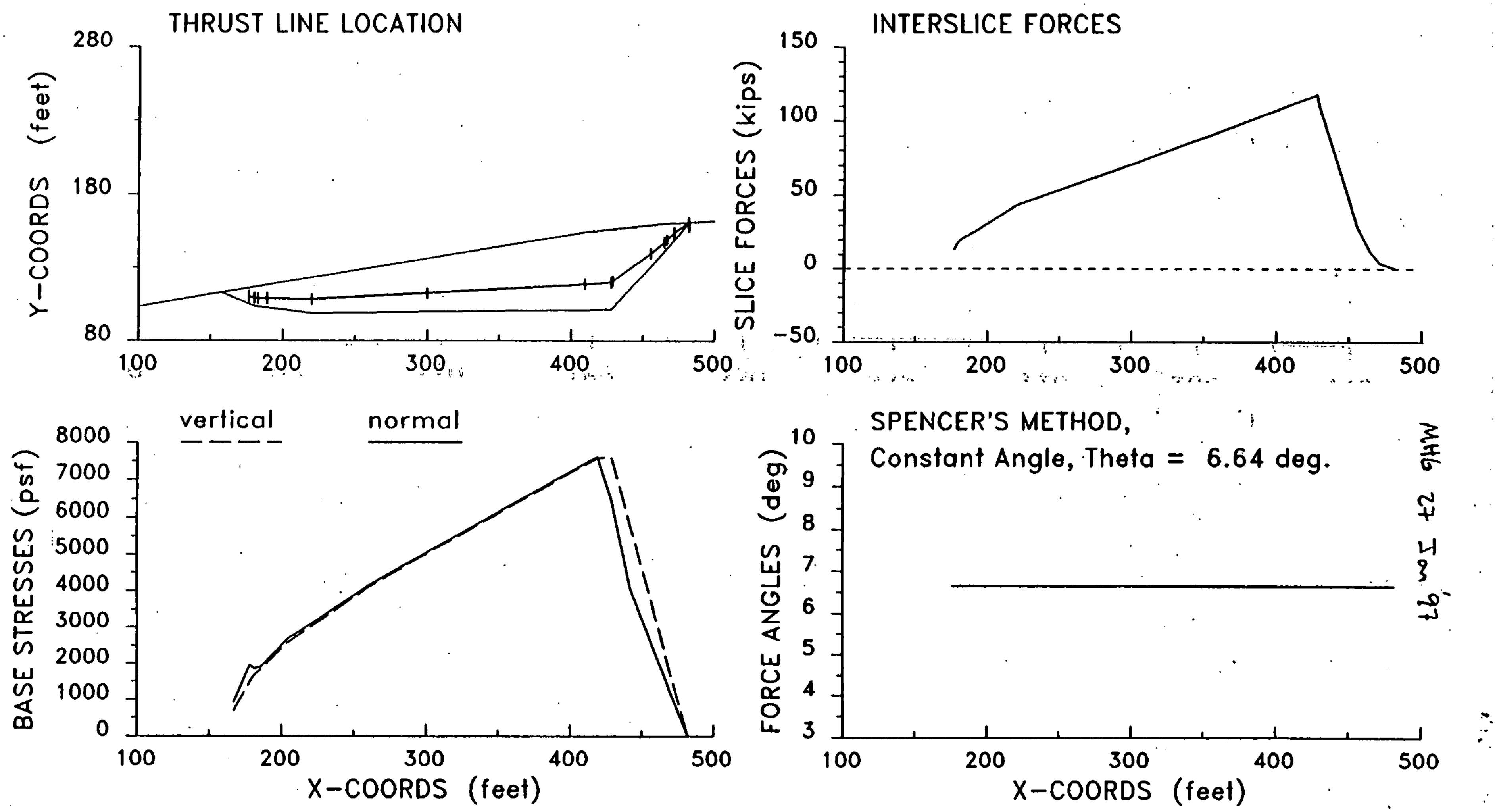

MHG 27 Jan 97

OSDF Final, long - unit wt 143 pcf
SPENCER'S METHOD, FOS for Specified Surface = 1.523

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*********************************************
*                X S T A B L                *
*                                           *
*        Slope Stability Analysis           *
*              using the                    *
*          Method of Slices                 *
*                                           *
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*********************************************
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Problem Description : OSDF Final, long - unit wt 143 pcf

SEGMENT BOUNDARY COORDINATES

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	5.5	95.6	35.5	100.6	2
2	35.5	100.6	62.5	99.3	2
3	62.5	99.3	67.0	97.5	2
4	67.0	97.5	410.0	154.7	2
5	410.0	154.7	465.0	160.2	2
6	465.0	160.2	555.0	164.7	2

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	60.0	90.0	120.0	100.0	2
2	120.0	100.0	150.0	105.0	2
3	150.0	105.0	183.0	105.0	2
4	183.0	105.0	189.0	106.0	1
5	189.0	106.0	410.0	142.8	1
6	410.0	142.8	467.0	148.5	1
7	467.0	148.5	555.0	152.9	1
8	183.0	105.0	220.0	100.0	6
9	220.0	100.0	300.0	100.8	5
10	300.0	100.8	410.0	102.0	4
11	410.0	102.0	555.0	103.5	3

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	125.0	125.0	.0	5.00	.000	.0	0
4	125.0	125.0	.0	6.00	.000	.0	0
5	125.0	125.0	.0	8.00	.000	.0	0
6	125.0	125.0	.0	10.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 7 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	157.53	112.60
2	180.25	103.47
3	220.00	99.00
4	428.25	101.18
5	455.60	130.37
6	481.96	160.45
7	482.22	161.06

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	166.99	108.80	5.38	18.91	-21.89	9.47	12707.
2	178.35	104.24	11.83	3.81	-21.89	9.47	5634.
3	181.63	103.32	13.30	2.75	-6.42	9.47	4572.
4	186.00	102.82	14.52	6.00	-6.42	9.47	10989.
5	204.50	100.74	19.69	31.00	-6.42	9.47	79907.
6	260.00	99.42	30.27	80.00	.60	9.47	327756.
7	355.00	100.41	45.11	110.00	.60	9.47	684167.
8	419.13	101.08	54.53	18.25	.60	5.71	138064.
9	428.73	101.69	54.88	.95	46.86	5.71	7278.
10	442.40	116.28	41.66	26.40	46.86	5.71	151579.
11	460.30	135.73	24.00	9.40	48.77	5.71	30243.
12	466.00	142.24	18.01	2.00	48.77	2.86	4725.
13	469.35	146.06	14.36	4.69	48.77	2.86	8642.
14	476.83	154.59	6.20	10.27	48.77	2.86	7955.
15	482.09	160.76	.30	.26	66.95	2.86	10.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment

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2	6.5968	1.5222	1.5497
3	6.6415	1.5228	1.5222

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	887.9	.0	30.00	0.	0.	0.	.00
2	1954.6	.0	30.00	0.	0.	0.	.00
3	1847.0	.0	30.00	0.	0.	0.	.00
4	1907.0	.0	10.00	0.	0.	0.	.00
5	2683.9	.0	10.00	0.	0.	0.	.00
6	4132.3	.0	8.00	0.	0.	0.	.00
7	6257.8	.0	6.00	0.	0.	0.	.00
8	7602.1	.0	5.00	0.	0.	0.	.00
9	6467.9	.0	5.00	0.	0.	0.	.00
10	4057.1	.0	25.00	0.	0.	0.	.00
11	2224.0	.0	25.00	0.	0.	0.	.00
12	1633.1	.0	25.00	0.	0.	0.	.00
13	1272.7	.0	25.00	0.	0.	0.	.00
14	509.3	.0	30.00	0.	0.	0.	.00
15	18.7	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	166.99	887.9	671.9	.0	336.6
2	178.35	1954.6	1479.2	.0	741.0
3	181.63	1847.0	1662.5	.0	700.2
4	186.00	1907.0	1831.5	.0	220.8
5	204.50	2683.9	2577.6	.0	310.8
6	260.00	4132.3	4096.9	.0	381.4
7	355.00	6257.8	6219.7	.0	431.9
8	419.13	7602.1	7565.1	.0	436.8
9	428.73	6467.9	7625.0	.0	371.6
10	442.40	4057.1	5742.6	.0	1242.3
11	460.30	2224.0	3217.3	.0	681.0
12	466.00	1633.1	2362.5	.0	500.1
13	469.35	1272.7	1841.2	.0	389.7
14	476.83	509.3	774.9	.0	193.1
15	482.09	18.7	37.4	.0	7.1

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	176.44	6.64	13200.	4.90	10.75	.456
2	180.25	6.64	19052.	5.06	12.92	.392
3	183.00	6.64	21566.	5.07	13.68	.370
4	189.00	6.64	24195.	5.81	15.36	.379
5	220.00	6.64	43313.	8.78	24.01	.365
6	300.00	6.64	70545.	12.23	36.52	.335
7	410.00	6.64	111122.	17.29	53.71	.322
8	428.25	6.64	117684.	18.21	55.35	.329
9	429.20	6.64	111408.	18.30	54.42	.336
10	455.60	6.64	29355.	9.27	28.89	.321
11	465.00	6.64	11783.	6.27	19.10	.328
12	467.00	6.64	9037.	5.82	16.92	.344
13	471.69	6.64	4016.	5.27	11.80	.447
14	481.96	6.64	5.	.29	.60	.481
15	482.22	.00	-5.	-2.58	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 4254.47 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 493.37 (psf)

Total Length of failure surface = 353.41 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.523

Total shear strength available
along specified failure surface = 265.52E+03 lb

MHG 27 Jan 97

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Calculations Added

Revision B

CASE7B3 1-28-97 18:26

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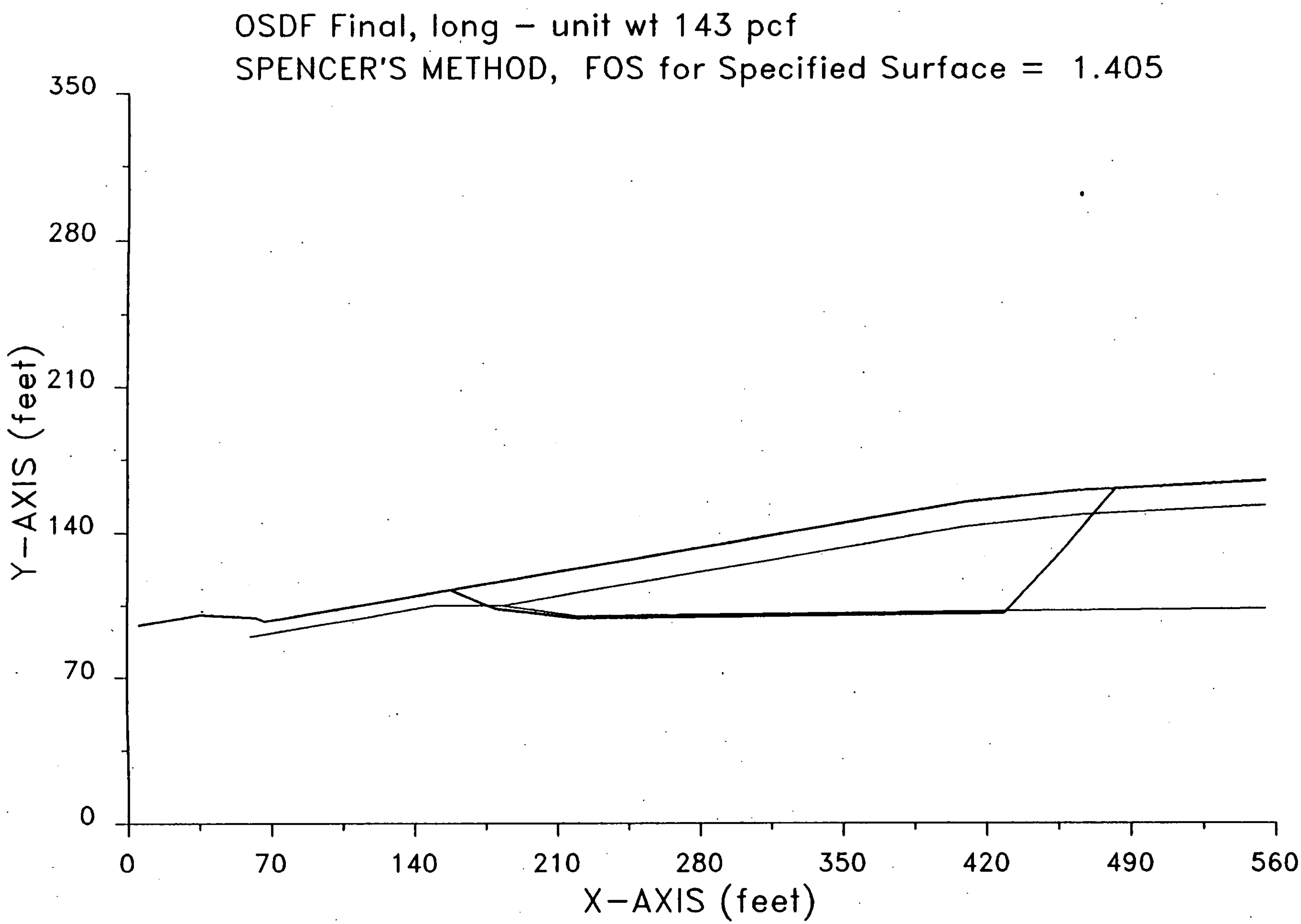
PJS 20Feb97



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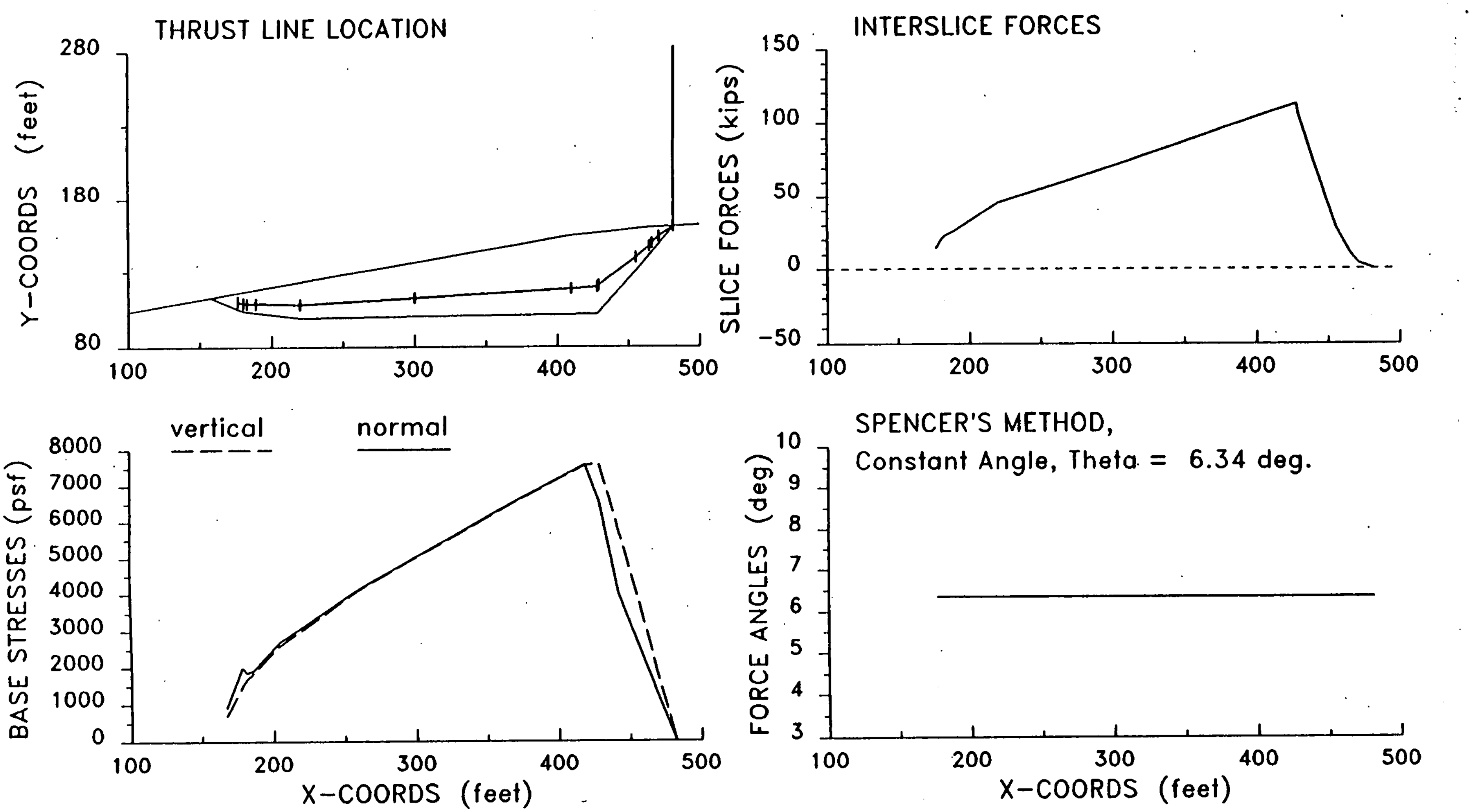
PTS 20Feb97



OSDF Final, long - unit wt 143 pcf
SPENCER'S METHOD, FOS for Specified Surface = 1.405

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RJS 20Feb97

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*********************************************
*                 X S T A B L               *
*                                           *
*         Slope Stability Analysis          *
*                 using the                 *
*             Method of Slices              *
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*  Ver. 5.100                   95 - 1305   *
*********************************************
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Problem Description : OSDF Final, long - unit wt 143 pcf

SEGMENT BOUNDARY COORDINATES

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	5.5	95.6	35.5	100.6	2
2	35.5	100.6	62.5	99.3	2
3	62.5	99.3	67.0	97.5	2
4	67.0	97.5	410.0	154.7	2
5	410.0	154.7	465.0	160.2	2
6	465.0	160.2	555.0	164.7	2

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	60.0	90.0	120.0	100.0	2
2	120.0	100.0	150.0	105.0	2
3	150.0	105.0	183.0	105.0	2
4	183.0	105.0	189.0	106.0	1
5	189.0	106.0	410.0	142.8	1
6	410.0	142.8	467.0	148.5	1
7	467.0	148.5	555.0	152.9	1
8	183.0	105.0	220.0	100.0	6
9	220.0	100.0	300.0	100.8	5
10	300.0	100.8	410.0	102.0	4
11	410.0	102.0	555.0	103.5	3

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	125.0	125.0	.0	4.00	.000	.0	0
4	125.0	125.0	.0	5.00	.000	.0	0
5	125.0	125.0	.0	7.00	.000	.0	0
6	125.0	125.0	.0	10.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 7 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	157.53	112.60
2	180.25	103.47
3	220.00	99.00
4	428.25	101.18
5	455.60	130.37
6	481.96	160.45
7	482.22	161.06

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	166.99	108.80	5.38	18.91	-21.89	9.47	12707.
2	178.35	104.24	11.83	3.81	-21.89	9.47	5634.
3	181.63	103.32	13.30	2.75	-6.42	9.47	4572.
4	186.00	102.82	14.52	6.00	-6.42	9.47	10989.
5	204.50	100.74	19.69	31.00	-6.42	9.47	79907.
6	260.00	99.42	30.27	80.00	.60	9.47	327756.
7	355.00	100.41	45.11	110.00	.60	9.47	684167.
8	419.13	101.08	54.53	18.25	.60	5.71	138064.
9	428.73	101.69	54.88	.95	46.86	5.71	7278.
10	442.40	116.28	41.66	26.40	46.86	5.71	151579.
11	460.30	135.73	24.00	9.40	48.77	5.71	30243.
12	466.00	142.24	18.01	2.00	48.77	2.86	4725.
13	469.35	146.06	14.36	4.69	48.77	2.86	8642.
14	476.83	154.59	6.20	10.27	48.77	2.86	7955.
15	482.09	160.76	.30	.26	66.95	2.86	10.

ITERATIONS FOR SPENCER'S METHOD

Iter #   Theta   FOS_force   FOS_moment

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PJS
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2	6.2925	1.4039	1.4327
3	6.3436	1.4046	1.4039

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	902.5	.0	30.00	0.	0.	0.	.00
2	1986.7	.0	30.00	0.	0.	0.	.00
3	1856.3	.0	30.00	0.	0.	0.	.00
4	1908.9	.0	10.00	0.	0.	0.	.00
5	2686.6	.0	10.00	0.	0.	0.	.00
6	4128.5	.0	7.00	0.	0.	0.	.00
7	6251.6	.0	5.00	0.	0.	0.	.00
8	7594.4	.0	4.00	0.	0.	0.	.00
9	6538.1	.0	4.00	0.	0.	0.	.00
10	3998.9	.0	25.00	0.	0.	0.	.00
11	2190.5	.0	25.00	0.	0.	0.	.00
12	1608.5	.0	25.00	0.	0.	0.	.00
13	1253.5	.0	25.00	0.	0.	0.	.00
14	499.9	.0	30.00	0.	0.	0.	.00
15	18.3	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	166.99	902.5	671.9	.0	371.0
2	178.35	1986.7	1479.2	.0	816.6
3	181.63	1856.3	1662.5	.0	763.0
4	186.00	1908.9	1831.5	.0	239.6
5	204.50	2686.6	2577.6	.0	337.3
6	260.00	4128.5	4096.9	.0	360.9
7	355.00	6251.6	6219.7	.0	389.4
8	419.13	7594.4	7565.1	.0	378.1
9	428.73	6538.1	7625.0	.0	325.5
10	442.40	3998.9	5742.6	.0	1327.5
11	460.30	2190.5	3217.3	.0	727.2
12	466.00	1608.5	2362.5	.0	534.0
13	469.35	1253.5	1841.2	.0	416.1
14	476.83	499.9	774.9	.0	205.5
15	482.09	18.3	37.4	.0	7.5

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	176.44	6.34	13957.	4.85	10.75	.451
2	180.25	6.34	20145.	5.01	12.92	.388
3	183.00	6.34	22834.	5.00	13.68	.366
4	189.00	6.34	25576.	5.73	15.36	.373
5	220.00	6.34	45519.	8.63	24.01	.360
6	300.00	6.34	71089.	12.13	36.52	.332
7	410.00	6.34	106942.	17.28	53.71	.322
8	428.25	6.34	112425.	18.23	55.35	.329
9	429.20	6.34	106036.	18.39	54.42	.338
10	455.60	6.34	27946.	9.29	28.89	.322
11	465.00	6.34	11182.	6.28	19.10	.329
12	467.00	6.34	8563.	5.82	16.92	.344
13	471.69	6.34	3773.	5.30	11.80	.449
14	481.96	6.34	3.	.30	.60	.508
15	482.22	.00	-6.	1686.06	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 4244.37 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 490.83 (psf)

Total Length of failure surface = 353.41 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.405

Total shear strength available
along specified failure surface = 243.65E+03 lb

ATTACHMENT B

REVISED SEISMIC SITE RESPONSE AND PERFORMANCE ANALYSIS

SEISMIC SITE RESPONSE AND PERFORMANCE ANALYSIS

EXECUTIVE SUMMARY

A seismic site response analysis and a performance analysis was performed for the On-Site Disposal Facility (OSDF). The analyses presented in this calculation package are identical to analyses presented in documents F9530029.CD (i.e., Seismic Site Response Analysis) and F9530055.CD (i.e., OSDF Seismic Performance Evaluation), with the exception that the unit weight of the impacted material has been increased from 125 pcf to 143 pcf. This increase in impacted material unit weight is to account for the possibility of additional ~~steel~~ metal debris in the impacted material.

The seismic site response analysis was performed to evaluate the peak average acceleration as well as the acceleration time history at the liner level of the facility. The analysis was performed using the computer program SHAKE91 (Idriss and Sun, 1991). A synthetic accelerogram B2-SYN, scaled to 0.16g, was used in the analysis. Results of the site response analysis indicate that the design seismic analysis induces a peak average acceleration of approximately 0.10 g at the liner OSDF level.

The performance analysis was performed to evaluate the potential for seismic deformation of the OSDF during the design seismic event. For the relevant stability conditions presented in the static stability analysis, a pseudo-static stability analysis is performed to obtain a yield acceleration. The yield acceleration is the horizontal acceleration (reported as a percentage of gravity) at which the factor of safety is equal to 1.0. This value is compared to the peak average acceleration obtained in the seismic site response evaluation. For two cases of concern, the yield acceleration is less than the peak average acceleration for the design seismic event. For these cases, a seismic deformation analysis was performed. Based on the results of this analysis, the maximum permanent seismic deformation for the OSDF during the design seismic event is expected to be less than 2.5 in (0.06 m). This calculated deformation is less than the maximum permissible seismic deformation of 6 in (0.15 m) based on the recommendations in Seed and Bonaparte (1992) and Anderson and Kavazanjian (1995). Therefore, the seismic performance of the OSDF during the design seismic event is acceptable.

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SEISMIC SITE RESPONSE AND PERFORMANCE ANALYSIS

PURPOSE

The purpose of this document is to perform a seismic response analysis and a seismic performance evaluation of the On-Site Disposal Facility (OSDF). The calculation packages provide a computation of the peak average acceleration as well as the acceleration time history at the liner level of the facility. The calculations also provide an evaluation, and if necessary, a calculation of the potential for permanent seismic deformation of the OSDF during the design seismic event.

This calculation package represents an amendment to the original calculations that are presented in the OSDF Final Design Calculation Package. The formats and procedures for the analyses presented in this calculation package are identical to analyses presented in documents F9530029.CD (i.e., Seismic Site Response Analysis) and F9530055.CD (i.e., Seismic Performance Evaluation), with the exception that the unit weight of the impacted material has been increased from 125 pcf to 143 pcf. This increase in impacted material unit weight is to account for the possibility of additional ~~steel~~ metal debris in the impacted material. 17 Feb 97

The potential for permanent seismic deformation is calculated for the base (foundation) and the impacted material mass, along the liner system. The permanent seismic deformation is calculated for selected impacted material configurations in which the yield acceleration (calculated in a pseudo-static stability analysis) exceeds the upper bound peak average acceleration at the liner level. The stability configurations considered in this analysis are for long-term interim conditions and for long-term final conditions.

PROCEDURE

Step 1 - Perform a one-dimensional total stress equivalent-linear site response analysis of the OSDF using the latest update of the SHAKE program, SHAKE91 (Idriss and Sun, 1991) along with the B2-SYN synthetic accelerogram and a representative site profile. The site profiles and dynamic properties used in the analysis are the ones corresponding to the Seismic Site Response Analysis package (i.e., document FER9530029.CD), with the exceptions noted herein.

Step 2 - Using the sections evaluated in the static stability analyses indicated above, perform a pseudo-static stability analysis to calculate the yield acceleration. The yield acceleration is the value of horizontal acceleration (measured as a percentage of gravity) at which the factor of safety for the critical slope stability interface is equal to 1.0. The computer program XSTABL (Sharma, 1994) is used in the pseudo-static stability analysis. Circular failure surfaces are evaluated using Bishop's

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Simplified Method (Bishop, 1955). Wedge failure surfaces are analyzed using Janbu's Method (Janbu, 1973).

Step 3 - For each case, compare the yield acceleration calculated in the previous step to the upper bound peak average acceleration for the foundation liner and cover system of the OSDF as presented in the results of the Seismic Site Response Analysis. Identify the conditions that require an evaluation of permanent seismic deformation as follows.

- For conditions in which the yield acceleration exceeds the upper bound peak average acceleration as calculated in Step 1, it is concluded that no permanent seismic deformations will occur and the analysis is complete.
- For conditions in which the yield acceleration is smaller than the upper bound peak average acceleration, permanent seismic deformations may occur during the seismic event and a Seismic Deformation Analysis is required.

Step 4 - For each stability condition requiring evaluation of permanent seismic deformations, perform a quantitative Newmark deformation analysis using the calculated yield acceleration from the pseudo-static limit equilibrium analysis and the acceleration time histories for the design earthquakes calculated in the Seismic Site Response Analysis. The yield acceleration and the average acceleration time history are entered into the validated Newmark computer program YSLIP_C (Yan, 1991). The permanent seismic deformation for cases requiring evaluation is then calculated.

Step 5 - For each case considered in Step 4, evaluate the potential for seismic upset to the OSDF by comparing the calculated deformation to the deformation levels considered to have the potential for impairment to the OSDF. The maximum permanent seismic deformation for all analysis conditions should be no larger than 6 in. (0.15 m) based on recommendations presented in Seed and Bonaparte (1992) and Anderson and Kavazanjian (1995).

DATA VERIFICATION

As stated in the PURPOSE section of this calculation package, these calculations are performed to calculate stability of the OSDF using an impacted material unit weight that is higher than that used in the original calculations. The increased unit weight represents the potential for a greater percentage of ~~steel~~ metal debris in the impacted material than was originally used in the calculations (i.e., original unit weight is 125 pcf). The revised unit weights is equal to 143 pcf. 17Feb97

Refer to the original calculation package provided in documents F9530020.CD (i.e., OSDF Foundation), F9530023.CD (i.e., Impacted Material Configuration), and F9530029.CD (i.e. Seismic Site Response Analysis) for all other data used in these analyses. The data used in this analysis (with the exception of impacted material unit weight) are identical to the data used in the original analyses.

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ANALYSIS

A seismic deformation analysis using SHAKE91 is performed to calculate the peak average shear stress and shear stress time history for the base of the impacted materials layer (liner) using the B2-SYN synthetic accelerogram (see document F9530028.CD, i.e., Seismic Hazard Assessment). The site profiles used in the analysis are the ones corresponding to the Seismic Site Response Analysis package (i.e., document FER9530029.CD), with the exception that the unit weight (γ) of impacted material (layers 3 to 7 in input file) has been increased from 125 pcf to 143 pcf. Accordingly, the shear wave velocity of the impacted material (V_s) has been decreased from 769 ft/sec to 719 ft/sec:

$$V_s = \sqrt{\frac{G_m g}{\gamma}}$$

with $G_m = 2300\,S_u$ (Seed and Idriss, 1970)

where g is the acceleration of gravity, G_m is the shear modulus of the impacted material, and S_u is the undrained shear stress (= 1,000 psf).

The B2-SYN synthetic accelerogram, developed at the California Institute of Technology, was scaled to 0.16g peak value prior to perform the site response analysis. The results are enclosed in the appendix to this calculation Package. These results indicate that the peak average shear stress at the level of interest (layer 8) is 827.96 psf. This shear stress corresponds to a peak average acceleration of 0.10g for an overburden pressure of 8,415 psf.

A pseudo-static stability analysis using XSTABL is performed to calculate the yield acceleration for the base (foundation) and the impacted material mass, along the liner system. The yield acceleration is the value of horizontal acceleration (reported as a percentage of gravity) at which the factor of safety is 1.0. The minimum yield acceleration for each case is reported in Table 1 and the XSTABL output for each yield acceleration case is attached to these calculations.

The yield acceleration, the peak average acceleration, and the acceleration ratio for both cases are presented in Table 1. In the cases analyzed, the yield acceleration is less than the peak average acceleration, hence a seismic deformation analysis was performed according to the procedures outlined previously.

By dividing the shear stress time history at the liner, obtained from the seismic site response analysis, by the overburden pressure (8,415 psf), a peak average acceleration time history for liner is obtained. To perform the seismic deformation analysis, the peak average acceleration time history for the liner layer is input into the validated Newmark computer program YSLIP_C (Yan, 1991).

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The permanent seismic deformation for each case was then calculated. The files for the seismic deformation analysis are attached to this calculation package. The results of this analysis are summarized in Table 1.

RESULTS

As indicated Table 1, the maximum permanent seismic deformation for the OSDF during the design seismic event is expected to be less than 2.5 in (0.06 m). This calculated deformation is less than the maximum permissible seismic deformation of 6 in. (0.15 m) based on the recommendations in Seed and Bonaparte (1992) and Anderson and Kavazanjian (1995). Therefore, the calculated seismic performance of the OSDF during the design seismic event is considered acceptable.

REFERENCES

1. Anderson, D.G. and Kavazanjian, E. Jr., "Performance of Landfills under Seismic Loading," *Proceedings of the 3rd International Conference on recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics*, St. Louis, Missouri, Vol. 3, 1995.

2. Bishop, A.W., "The Use of the Slip Circle in the Stability Analysis of Slopes," *Geotechnique*, Vol. 5, No. 1, March 1955, pp 7-17.

3. Idriss, I.M. and Sun, J. I., "SHAKE91: A computer Program for Conducting Equivalent Linear Seismic Response Analyses of Horizontally Layered Soil Deposits", Department of Civil and Environmental engineering, University of California, Davis, 1991.

4. Janbu, N., "Slope Stability Computations", *Embankment Dam Engineering*, Cassagrande Memorial Volume, Hirschfeld and Poulos, (Eds), John Wiley, New York, 1978 pp 47-86.

5. Seed, R.B., and Bonaparte, R., "Seismic Analysis and Design of Lined Waste Fills: Current Practice," *Proceedings, Stability and Performance of Slopes and Embankments-II*, Vol. 2, ASCE Geotechnical Special Publication No. 31, Berkeley, California, pp 1521-1545, 1992.

6. Sharma, S., "*XSTABL: An Integrated Slope Stability Analysis Program for Personal Computers, Version 5*", Interactive Software Designs, Moscow, ID, 1994.

7. Yan, L.P., "*Seismic Deformation Analysis of Earth Dams: A Simplified Method*", Research Report No. SML-91-01, California Institute of Technology, Soil Mechanics Laboratory, Pasadena, California, 1991.

TABLE 1

EVALUATION SUMMARY

Seismic Performance Evaluation
Fernald Environmental Management Project
On-Site Disposal Facility
Fernald, Ohio

Case	Yield Acceleration(1) (g)	Peak Average Acceleration(2)	Acceleration Ratio(3)	Permanent Seismic Deformation(3)
OSDF Foundation	0.08	0.10	0.8	0.08 in.
OSDF Liner System and Impacted Materials	0.05	0.10	0.5	2.5 in.

Notes:

(1) Calculated in pseudo-static stability analysis using XSTABL.
(2) Calculated in the Seismic Site Response Analysis using SHAKE (Step 1).
(3) Ratio of yield to peak average acceleration (if greater than 1, no permanent seismic deformation is expected)
(4) Calculated using YSLIP_C.

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Mmb 97-2-12

SHAKE OUTPUT FILES

```
************************************************************
* SHAKE  --   A COMPUTER PROGRAM FOR EARTHQUAKE RESPONSE   *
*             ANALYSIS OF HORIZONTALLY LAYERED SITES       *
*             by: Per B. Schnabel & John Lysmer -- 1970    *
* -------------------------------------------------------- *
* shake85     IBM-PC version of SHAKE                      *
*             by: S.S. (Willie) Lai, January 1985          *
* -------------------------------------------------------- *
* shake88   : New modulus reduction curves for clays added*
*             using results from Sun et al (1988)          *
*             by: J. I. Sun & Ramin Golesorkhi             *
*             February 26, 1988                            *
* -------------------------------------------------------- *
* SHAKE90/91: Adjust last iteration; Input now is either   *
*             Gmax or max Vs; up to 13 material types can *
*             be specified by user; up to 50 Layers can    *
*             be specified; object motion can be read in   *
*             from a separate file and can have user       *
*             specified format; Different periods for      *
*             response spectral calculations; options      *
*             are renumbered; and general cleanup          *
*             by: J. I. Sun, I. M. Idriss & P. Dirrim      *
*             June 1990 - February 1991                    *
* -------------------------------------------------------- *
* SHAKE91   : General cleanup and finalization of input/   *
*             output format ... etc                        *
*             by: I. M. Idriss                             *
*             December 1991                                *
************************************************************
```

MAX. NUMBER OF TERMS IN FOURIER TRANSFORM = 4096
NECESSARY LENGTH OF BLANK COMMON X = 25619

1****** OPTION 1 *** READ RELATION BETWEEN SOIL PROPERTIES AND STRAIN

****
MATERIAL TYPE NO. 5
****

CURVE NO. 9: #5 Modulus for CL (PI=15) (Vucetic and Dobry, 1991)
CURVE NO. 10: #5 Damping for CL (PI=15) (Vucetic and Dobry, 1991)

CURVE NO. 9 STRAIN	G/Gmax	CURVE NO.10 STRAIN	DAMPING
.0001	1.000	.0001	.82
.0003	1.000	.0003	1.04
.0010	.992	.0010	1.55
.0040	.917	.0030	2.58
.0100	.824	.0100	4.64
.0400	.597	.0300	7.77
.1000	.407	.1000	11.67
.4000	.179	.3000	16.08
.6000	.134	1.0000	20.12
1.0000	.092	.0000	.00

****
MATERIAL TYPE NO. 2
****

CURVE NO. 3: #2 Modulus for Sand (Seed & Idriss, 1970) - upper Range
CURVE NO. 4: #2 Damping for Sand (Idriss, 1990) - (about LRng from S

CURVE NO. 3 STRAIN	G/Gmax	CURVE NO. 4 STRAIN	DAMPING
.0001	1.000	.0001	.24
.0003	1.000	.0003	.42
.0010	.990	.0010	.80
.0030	.960	.0030	1.40
.0100	.850	.0100	2.80
.0300	.640	.0300	5.10
.1000	.370	.1000	9.80
.3000	.180	.3000	15.50
1.0000	.080	1.0000	21.00
3.0000	.050	3.0000	25.00
10.0000	.035	10.0000	28.00

****
MATERIAL TYPE NO. 3
****

CURVE NO. 5: #3 ATTENUATION OF ROCK AVERAGE
CURVE NO. 6: #3 DAMPING IN ROCK

CURVE NO. 5 STRAIN	G/Gmax	CURVE NO. 6 STRAIN	DAMPING
.0001	1.000	.0001	.40
.0003	1.000	.0010	.80
.0010	.988	.0100	1.50
.0030	.952	.1000	3.00
.0100	.900	1.0000	4.60
.0300	.810	.0000	.00
.1000	.725	.0000	.00
1.0000	.550	.0000	.00

1****** OPTION 2 *** READ SOIL PROFILE
NEW SOIL PROFILE NO. 1 IDENTIFICATION CASE 3 - The Most Crit. Prof.
=>
NUMBER OF LAYERS 14 DEPTH TO BEDROCK 287.00

NO. =>	TYPE EL	THICKNESS (ft)	DEPTH (ft)	Tot. PRESS. (ksf)	MODULUS (ksf)	DAMPING	UNIT WT. (kcf)	SHEAR V (fps)
1	2	3.00	1.50	.19	564.	.050	.125	381.0
2	2	4.00	5.00	.50	564.	.050	.125	381.0
3	5	10.00	12.00	1.03	2296.	.050	.143	719.0
4	5	10.00	22.00	1.83	2296.	.050	.143	719.0
5	5	10.00	32.00	2.64	2296.	.050	.143	719.0
6	5	10.00	42.00	3.45	2296.	.050	.143	719.0
7	5	10.00	52.00	4.25	2296.	.050	.143	719.0
8	5	3.00	58.50	4.76	2869.	.050	.130	843.0
9	5	5.00	62.50	5.04	2758.	.050	.135	811.0
10	5	5.00	67.50	5.40	2758.	.050	.135	811.0
11	5	10.00	75.00	6.00	4360.	.050	.145	984.0
12	5	35.00	97.50	7.86	4360.	.050	.145	984.0
13	2	172.00	201.00	15.54	3001.	.050	.135	846.0
14	BASE				450311.	.100	.145	10000.0

PERIOD = 1.38 FROM AVERAGE SHEAR VELOCITY = 833.

FREQUENCY AMPLITUDE
MAXIMUM AMPLIFICATION = 12.68
FOR FREQUENCY = .73 C/SEC.
PERIOD = 1.36 SEC.

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1****** OPTION 3 *** READ INPUT MOTION

FILE NAME FOR INPUT MOTION = B2-SYN.sar
NO. OF INPUT ACC. POINTS = 2000
NO. OF POINTS USED IN FFT = 4096
NO. OF HEADING LINES = 3
NO. OF POINTS PER LINE = 8
TIME STEP FOR INPUT MOTION = .0250
FORMAT FOR OF TIME HISTORY = (8F9.6)

***** H E A D E R
B2 SYNTHETIC M 7 EARTHQUAKE (Jennings et al., 1968)
Max. (in file) = 0.315077 g @ 4.68 sec; RMS freq. = 3.28 Hz
8 * 250 = 2000 pts. @ 0.025 sec; 8F9.6
** FIRST & LAST 5 LINES OF INPUT MOTION *****

1	.000000	-.000191	-.000399	-.000632	-.000888	-.001092	-.001243	-.001437
2	-.001835	-.002398	-.002842	-.002946	-.003019	-.002256	-.000859	-.000274
3	-.001190	-.002239	-.001787	-.000404	.001028	.000773	-.000755	-.002586
4	-.004002	-.004247	-.004716	-.006834	-.008546	-.009391	-.008594	-.007142
5	-.003566	.000028	.004129	.004172	.001735	.003682	.002997	-.000622

.... INPUT MOTION READ NOT ECHOED..........

246	-.002408	-.003898	-.005588	-.004314	.001070	.002833	.003657	.005944
247	.009774	.008337	.004462	.006259	.007700	.007975	.009049	.007827
248	.000034	-.004254	-.005640	-.011432	-.014924	-.016667	-.012866	-.009277
249	-.007880	-.005180	-.003704	-.007066	-.013307	-.012550	-.009212	-.005912
250	-.001681	.002323	.007857	.009733	.005098	.001221	-.002116	-.006346

MAXIMUM ACCELERATION = .31508
AT TIME = 4.68 SEC
THE VALUES WILL BE MULTIPLIED BY A FACTOR = .508
TO GIVE NEW MAXIMUM ACCELERATION = .16000
MEAN SQUARE FREQUENCY = 3.28 C/SEC.
1****** OPTION 4 *** READ WHERE OBJECT MOTIUN IS GIVEN
OBJECT MOTION IN LAYER NUMBER 14 OUTCROPPING

1****** OPTION 5 *** OBTAIN STRAIN COMPATIBLE SOIL PROPERTIES
MAXIMUM NUMBER OF ITERATIONS = 10
FACTOR FOR UNIFORM STRAIN IN TIME DOMAIN = .65

EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 1

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING NEW	USED	----> ERROR	<---- SHEAR MODULUS NEW	USED	-----> ERROR	G/Go RATIO
1	2	1.5	.00692	.024	.050	-110.8	497.9	563.5	-13.2	1.000
2	2	5.0	.02281	.045	.050	-10.5	390.1	563.5	-44.4	1.000
3	5	12.0	.01369	.055	.050	9.7	1773.7	2295.8	-29.4	1.000
4	5	22.0	.02489	.072	.050	30.9	1549.0	2295.8	-48.2	1.000
5	5	32.0	.03481	.083	.050	39.4	1422.8	2295.8	-61.4	1.000
6	5	42.0	.04312	.089	.050	44.1	1334.8	2295.8	-72.0	1.000
7	5	52.0	.05127	.095	.050	47.4	1252.4	2295.8	-83.3	1.000
8	5	58.5	.04526	.091	.050	45.1	1639.4	2869.1	-75.0	1.000
9	5	62.5	.04958	.094	.050	46.8	1523.5	2757.5	-81.0	1.000
10	5	67.5	.05260	.096	.050	47.9	1489.6	2757.5	-85.1	1.000
11	5	75.0	.03609	.084	.050	40.3	2676.4	4360.2	-62.9	1.000
12	5	97.5	.04499	.091	.050	45.0	2496.7	4360.2	-74.6	1.000
13	2	201.0	.08128	.090	.050	44.4	1249.8	3000.7	-140.1	1.000

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 2

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING NEW	USED	----> ERROR	<---- SHEAR MODULUS NEW	USED	-----> ERROR	G/Go RATIO
1	2	1.5	.00357	.016	.024	-48.0	532.0	497.9	6.4	.884
2	2	5.0	.01512	.037	.045	-23.5	434.4	390.1	10.2	.692
3	5	12.0	.00819	.043	.055	-28.7	1938.2	1773.7	8.5	.773
4	5	22.0	.01711	.062	.072	-17.3	1689.8	1549.0	8.3	.675
5	5	32.0	.02589	.074	.083	-12.3	1534.1	1422.8	7.3	.620
6	5	42.0	.03409	.082	.089	-9.3	1430.7	1334.8	6.7	.581
7	5	52.0	.04224	.089	.095	-7.1	1344.6	1252.4	6.9	.546
8	5	58.5	.03457	.082	.091	-10.6	1781.3	1639.4	8.0	.571
9	5	62.5	.03855	.086	.094	-9.5	1662.9	1523.5	8.4	.552
10	5	67.5	.04091	.088	.096	-9.3	1633.4	1489.6	8.8	.540
11	5	75.0	.02399	.071	.084	-17.3	2968.0	2676.4	9.8	.614
12	5	97.5	.02724	.075	.091	-21.2	2877.3	2496.7	13.2	.573
13	2	201.0	.09255	.095	.090	5.3	1162.3	1249.8	-7.5	.416

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 3

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING NEW	USED	----> ERROR	<---- SHEAR MODULUS NEW	USED	-----> ERROR	G/Go RATIO
1	2	1.5	.00306	.014	.016	-12.7	540.0	532.0	1.5	.944
2	2	5.0	.01241	.033	.037	-12.7	455.7	434.4	4.7	.771
3	5	12.0	.00688	.040	.043	-7.5	1979.0	1938.2	2.1	.844
4	5	22.0	.01444	.057	.062	-8.5	1753.5	1689.8	3.6	.736
5	5	32.0	.02267	.070	.074	-5.4	1584.0	1534.1	3.1	.668
6	5	42.0	.03067	.078	.082	-4.4	1470.4	1430.7	2.7	.623
7	5	52.0	.03796	.085	.089	-4.1	1390.2	1344.6	3.3	.586
8	5	58.5	.03069	.078	.082	-4.9	1837.3	1781.3	3.0	.621
9	5	62.5	.03382	.082	.086	-5.2	1722.0	1662.9	3.4	.603
10	5	67.5	.03556	.083	.088	-5.5	1699.4	1633.4	3.9	.592
11	5	75.0	.02035	.067	.071	-7.0	3085.6	2968.0	3.8	.681
12	5	97.5	.02289	.070	.075	-7.1	3001.7	2877.3	4.1	.660
13	2	201.0	.09906	.098	.095	2.7	1116.6	1162.3	-4.1	.387

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

MHB 97-2-12

ITERATION NUMBER 4

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING NEW	USED	----> ERROR	<---- SHEAR MODULUS NEW	USED	-----> ERROR	G/Go RATIO
1	2	1.5	.00288	.014	.014	-3.1	541.6	540.0	.3	.958
2	2	5.0	.01126	.030	.033	-6.7	466.2	455.7	2.3	.809
3	5	12.0	.00645	.039	.040	-2.8	1994.0	1979.0	.8	.862
4	5	22.0	.01355	.055	.057	-3.3	1777.6	1753.5	1.4	.764
5	5	32.0	.02139	.068	.070	-2.4	1605.9	1584.0	1.4	.690
6	5	42.0	.02899	.077	.078	-2.2	1491.7	1470.4	1.4	.640
7	5	52.0	.03554	.083	.085	-2.6	1415.0	1390.2	1.8	.606
8	5	58.5	.02877	.077	.078	-2.5	1867.7	1837.3	1.6	.640

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9	5	62.5	.03159	.079	.082	-2.8	1752.8	1722.0	1.8	.624
10	5	67.5	.03314	.081	.083	-2.8	1731.3	1699.4	1.8	.616
11	5	75.0	.01899	.065	.067	-3.0	3135.1	3085.6	1.6	.708
12	5	97.5	.02180	.069	.070	-2.0	3036.4	3001.7	1.1	.688
13	2	201.0	.09846	.097	.098	-.2	1120.7	1116.6	.4	.372

1

EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 5

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH	UNIFRM.	<----	DAMPING	---->	<----	SHEAR MODULUS	----->	G/Go
		(FT)	STRAIN	NEW	USED	ERROR	NEW	USED	ERROR	RATIO
1	2	1.5	.00292	.014	.014	.5	541.4	541.6	.0	.961
2	2	5.0	.01115	.030	.030	-.7	467.2	466.2	.2	.827
3	5	12.0	.00649	.039	.039	.3	1992.3	1994.0	-.1	.869
4	5	22.0	.01353	.055	.055	-.1	1778.2	1777.6	.0	.774
5	5	32.0	.02139	.068	.068	.0	1605.8	1605.9	.0	.699
6	5	42.0	.02902	.077	.077	.0	1491.3	1491.7	.0	.650
7	5	52.0	.03553	.083	.083	.0	1415.2	1415.0	.0	.616
8	5	58.5	.02880	.077	.077	.0	1867.1	1867.7	.0	.651
9	5	62.5	.03156	.079	.079	.0	1753.2	1752.8	.0	.636
10	5	67.5	.03287	.081	.081	-.3	1734.9	1731.3	.2	.628
11	5	75.0	.01888	.065	.065	-.2	3138.9	3135.1	.1	.719
12	5	97.5	.02151	.068	.069	-.6	3046.0	3036.4	.3	.696
13	2	201.0	.09853	.097	.097	.0	1120.2	1120.7	.0	.373

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 6

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH	UNIFRM.	<----	DAMPING	---->	<----	SHEAR MODULUS	----->	G/Go
		(FT)	STRAIN	NEW	USED	ERROR	NEW	USED	ERROR	RATIO
1	2	1.5	.00292	.014	.014	.0	541.4	541.4	.0	.961
2	2	5.0	.01113	.030	.030	-.1	467.5	467.2	.0	.829
3	5	12.0	.00650	.039	.039	.0	1992.2	1992.3	.0	.868
4	5	22.0	.01353	.055	.055	.0	1778.2	1778.2	.0	.775
5	5	32.0	.02140	.068	.068	.0	1605.8	1605.8	.0	.699
6	5	42.0	.02903	.077	.077	.0	1491.1	1491.3	.0	.650
7	5	52.0	.03553	.083	.083	.0	1415.2	1415.2	.0	.616
8	5	58.5	.02881	.077	.077	.0	1866.9	1867.1	.0	.651
9	5	62.5	.03155	.079	.079	.0	1753.3	1753.2	.0	.636
10	5	67.5	.03280	.081	.081	-.1	1735.8	1734.9	.1	.629
11	5	75.0	.01886	.064	.065	-.1	3139.9	3138.9	.0	.720
12	5	97.5	.02144	.068	.068	-.1	3048.3	3046.0	.1	.699
13	2	201.0	.09851	.097	.097	.0	1120.4	1120.2	.0	.373

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 7

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH	UNIFRM.	<----	DAMPING	---->	<----	SHEAR MODULUS	----->	G/Go
		(FT)	STRAIN	NEW	USED	ERROR	NEW	USED	ERROR	RATIO
1	2	1.5	.00292	.014	.014	.0	541.4	541.4	.0	.961
2	2	5.0	.01113	.030	.030	.0	467.5	467.5	.0	.830
3	5	12.0	.00650	.039	.039	.0	1992.0	1992.2	.0	.868
4	5	22.0	.01353	.055	.055	.0	1778.1	1778.2	.0	.775
5	5	32.0	.02141	.068	.068	.0	1605.7	1605.8	.0	.699
6	5	42.0	.02904	.077	.077	.0	1491.0	1491.1	.0	.649
7	5	52.0	.03554	.083	.083	.0	1415.0	1415.2	.0	.616
8	5	58.5	.02883	.077	.077	.0	1866.7	1866.9	.0	.651
9	5	62.5	.03157	.079	.079	.0	1753.2	1753.3	.0	.636
10	5	67.5	.03280	.081	.081	.0	1735.8	1735.8	.0	.629
11	5	75.0	.01886	.064	.064	.0	3139.9	3139.9	.0	.720
12	5	97.5	.02142	.068	.068	.0	3048.8	3048.3	.0	.699
13	2	201.0	.09851	.097	.097	.0	1120.3	1120.4	.0	.373

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 8

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH	UNIFRM.	<----	DAMPING	---->	<----	SHEAR MODULUS	----->	G/Go
		(FT)	STRAIN	NEW	USED	ERROR	NEW	USED	ERROR	RATIO
1	2	1.5	.00292	.014	.014	.0	541.4	541.4	.0	.961
2	2	5.0	.01113	.030	.030	.0	467.5	467.5	.0	.830
3	5	12.0	.00650	.039	.039	.0	1992.1	1992.0	.0	.868
4	5	22.0	.01353	.055	.055	.0	1778.1	1778.1	.0	.775
5	5	32.0	.02141	.068	.068	.0	1605.6	1605.7	.0	.699
6	5	42.0	.02904	.077	.077	.0	1490.9	1491.0	.0	.649
7	5	52.0	.03554	.083	.083	.0	1415.0	1415.0	.0	.616
8	5	58.5	.02883	.077	.077	.0	1866.7	1866.7	.0	.651
9	5	62.5	.03157	.079	.079	.0	1753.2	1753.2	.0	.636
10	5	67.5	.03280	.081	.081	.0	1735.9	1735.8	.0	.629
11	5	75.0	.01886	.064	.064	.0	3140.0	3139.9	.0	.720
12	5	97.5	.02142	.068	.068	.0	3049.0	3048.8	.0	.699
13	2	201.0	.09851	.097	.097	.0	1120.3	1120.3	.0	.373

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 9

VALUES IN TIME DOMAIN

NO	TYPE	DEPTH	UNIFRM.	<----	DAMPING	---->	<----	SHEAR MODULUS	----->	G/Go
		(FT)	STRAIN	NEW	USED	ERROR	NEW	USED	ERROR	RATIO
1	2	1.5	.00292	.014	.014	.0	541.4	541.4	.0	.961
2	2	5.0	.01113	.030	.030	.0	467.5	467.5	.0	.830
3	5	12.0	.00650	.039	.039	.0	1992.1	1992.1	.0	.868
4	5	22.0	.01353	.055	.055	.0	1778.1	1778.1	.0	.775
5	5	32.0	.02141	.068	.068	.0	1605.6	1605.6	.0	.699
6	5	42.0	.02904	.077	.077	.0	1490.9	1490.9	.0	.649
7	5	52.0	.03555	.083	.083	.0	1415.0	1415.0	.0	.616
8	5	58.5	.02883	.077	.077	.0	1866.7	1866.7	.0	.651
9	5	62.5	.03157	.079	.079	.0	1753.2	1753.2	.0	.636
10	5	67.5	.03280	.081	.081	.0	1735.9	1735.9	.0	.629
11	5	75.0	.01886	.064	.064	.0	3140.0	3140.0	.0	.720
12	5	97.5	.02142	.068	.068	.0	3049.0	3049.0	.0	.699
13	2	201.0	.09851	.097	.097	.0	1120.3	1120.3	.0	.373

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EARTHQUAKE - B2-SYN.sar
SOIL PROFILE - CASE 3 - The Most Crit. Prof.

ITERATION NUMBER 10

VALUES IN TIME DOMAIN

MHS 2.12.97

1033

10/30

NO	TYPE	DEPTH (FT)	UNIFRM. STRAIN	<---- DAMPING ----> NEW	USED	ERROR	<---- SHEAR MODULUS -----> NEW	USED	ERROR	G/Go RATIO
1	2	1.5	.00292	.014	.014	.0	541.4	541.4	.0	.961
2	2	5.0	.01113	.030	.030	.0	467.5	467.5	.0	.830
3	5	12.0	.00650	.039	.039	.0	1992.1	1992.1	.0	.868
4	5	22.0	.01353	.055	.055	.0	1778.1	1778.1	.0	.775
5	5	32.0	.02141	.068	.068	.0	1605.6	1605.6	.0	.699
6	5	42.0	.02904	.077	.077	.0	1490.9	1490.9	.0	.649
7	5	52.0	.03555	.083	.083	.0	1415.0	1415.0	.0	.616
8	5	58.5	.02883	.077	.077	.0	1866.7	1866.7	.0	.651
9	5	62.5	.03157	.079	.079	.0	1753.2	1753.2	.0	.636
10	5	67.5	.03280	.081	.081	.0	1735.9	1735.9	.0	.629
11	5	75.0	.01886	.064	.064	.0	3140.0	3140.0	.0	.720
12	5	97.5	.02142	.068	.068	.0	3049.0	3049.0	.0	.699
13	2	201.0	.09851	.097	.097	.0	1120.3	1120.3	.0	.373

VALUES IN TIME DOMAIN

LAYER	TYPE	=> TIME SEC	THICKNESS FT	DEPTH FT	MAX STRAIN PRCNT	MAX STRESS PSF
1	2	9.35	3.0	1.5	.00449	24.31
2	2	9.35	4.0	5.0	.01712	80.02
3	5	9.35	10.0	12.0	.01000	199.27
4	5	9.38	10.0	22.0	.02081	370.10
5	5	9.38	10.0	32.0	.03293	528.78
6	5	9.38	10.0	42.0	.04468	666.19
7	5	9.38	10.0	52.0	.05469	773.79
8	5	9.38	3.0	58.5	.04436	827.96
9	5	9.38	5.0	62.5	.04856	851.40
10	5	9.38	5.0	67.5	.05046	875.93
11	5	9.40	10.0	75.0	.02901	910.86
12	5	16.18	35.0	97.5	.03295	1004.64
13	2	16.05	172.0	201.0	.15156	1697.95

PERIOD = 1.97 FROM AVERAGE SHEAR VELOCITY = 584.

FREQUENCY AMPLITUDE
MAXIMUM AMPLIFICATION = 6.31
FOR FREQUENCY = .45 C/SEC.
PERIOD = 2.21 SEC.

1****** OPTION 6 *** COMPUTE MOTION IN NEW SUBLAYERS

EARTHQUAKE -B2-SYN.sar
SOIL DEPOSIT - CASE 3 - The Most Crit. Prof.

LAYER	DEPTH FT	MAX. ACC. G	TIME SEC	MEAN SQ. FR. C/SEC	=> ACC. RATIO QUIET ZONE	TH SAVED ACC. RECORD
WITHIN	.0	.13060	9.35	1.63	.001	0
WITHIN	3.0	.13012	9.35	1.61	.001	0
WITHIN	7.0	.12739	9.35	1.52	.001	0
WITHIN	17.0	.12229	9.35	1.43	.001	0
WITHIN	27.0	.11376	9.38	1.29	.001	0
WITHIN	37.0	.10004	9.38	1.16	.001	0
WITHIN	47.0	.08660	10.13	1.07	.001	0
WITHIN	57.0	.07759	16.20	1.05	.001	0
WITHIN	60.0	.07767	16.20	1.06	.002	0
WITHIN	65.0	.07718	16.20	1.09	.001	0
WITHIN	287.0	.15143	4.68	3.27	.001	0
OUTCR.	287.0	.15983	4.68	3.28	.001	0

1****** OPTION 7 *** COMPUTE STRESS/STRAIN HISTORY

COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF LAYER 9
SCALE FOR PLOTTING .0000
IDENTIFICATION - -- stress in level 8

COMPUTE STRESS OR STRAIN HISTORY AT THE TOP OF LAYER 9
SCALE FOR PLOTTING .0000
IDENTIFICATION - -- strain in level 8

$$a_x = \frac{827.56\,psf}{8415\,psf} = 0.098$$

MHG 97-2-12

0001522

E05 11/36

in ksf

STRESS -- stress in level 8 LAYER 9

.001326	.000883	.001322	.000878	.001317	.000872	.001309	.000863	1
.001298	.000849	.001279	.000823	.001244	.000776	.001177	.000676	2
.001019	.000412	.000584	-.000255	-.000354	-.001479	-.001864	-.003274	3
-.003956	-.005677	-.006625	-.008463	-.009291	-.010708	-.010802	-.011353	4
-.010774	-.010963	-.010087	-.009778	-.008329	-.007858	-.007073	-.008016	5
-.008892	-.011299	-.013467	-.017357	-.021226	-.026407	-.030370	-.034070	6
-.035092	-.034838	-.031578	-.027551	-.021738	-.016493	-.010841	-.007846	7
-.007025	-.010442	-.015358	-.022012	-.027394	-.032896	-.036483	-.038668	8
-.036092	-.029985	-.020009	-.010586	-.002765	-.001127	-.006089	-.019407	9
-.036213	-.053975	-.067515	-.076180	-.077611	-.074268	-.064086	-.048016	10
-.026325	-.005041	.015883	.033944	.049181	.060555	.071641	.081220	11
.091564	.101273	.111472	.118177	.120998	.118768	.115031	.108258	12
.100309	.090598	.082919	.078232	.080369	.086290	.093157	.095498	13
.091385	.075825	.052395	.023162	-.008155	-.042646	-.078779	-.117726	14
-.153521	-.182202	-.198619	-.204058	-.196957	-.179766	-.155166	-.131922	15
-.113441	-.102193	-.095080	-.092407	-.087449	-.077949	-.063958	-.047982	16
-.028371	-.012407	-.005751	-.017866	-.050254	-.098461	-.153199	-.209879	17
-.257353	-.287156	-.289414	-.259555	-.190954	-.086278	.044003	.174356	18
.282676	.361432	.421290	.462963	.479229	.463740	.430255	.399526	19
.390288	.401236	.422221	.442547	.464834	.486588	.499857	.492010	20
.457086	.389307	.295537	.182850	.059190	-.064897	-.165565	-.231102	21
-.264183	-.274277	-.264888	-.237381	-.187730	-.129189	-.081642	-.061387	22
-.066892	-.092547	-.122791	-.145192	-.157809	-.171577	-.192697	-.221709	23
-.243976	-.250514	-.243628	-.245656	-.271134	-.311511	-.341305	-.347796	24
-.328370	-.293317	-.251566	-.214415	-.184635	-.161708	-.137456	-.104634	25
-.052231	.026467	.138255	.279633	.438456	.586409	.696794	.743460	26
.710957	.593576	.409553	.198489	.007718	-.142993	-.255071	-.334442	27
-.369961	-.355303	-.299265	-.231466	-.176609	-.143952	-.125705	-.117868	28
-.119619	-.134137	-.155735	-.180664	-.197665	-.193245	-.154015	-.087071	29
-.008581	.068366	.144261	.207901	.241838	.230822	.167262	.046044	30
-.114326	-.289165	-.456021	-.599298	-.700414	-.744543	-.716290	-.609833	31
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.012801	.019427	.027861	.036288	.045756	.053626	.060483	.063585	237
.064905	.063076	.059556	.052776	.045600	.037547	.031784	.027835	238
.027874	.029647	.034161	.038569	.043278	.045714	.047585	.047102	239
.045649	.041266	.035953	.028502	.021632	.014715	.010567	.008008	240
.008608	.010013	.013528	.017048	.021687	.024358	.025187	.021821	241
.016580	.008384	-.000214	-.010226	-.019368	-.028620	-.035076	-.039695	242
-.040391	-.039102	-.034932	-.030579	-.024838	-.020109	-.015613	-.014211	243
-.014682	-.018306	-.022150	-.026951	-.030476	-.034420	-.036958	-.039370	244
-.039585	-.039681	-.038478	-.038335	-.037708	-.037956	-.036429	-.034097	245
-.029256	-.024564	-.019284	-.015696	-.011933	-.009836	-.008031	-.008018	246
-.007536	-.007788	-.006038	-.003748	.000412	.004378	.009565	.013304	247
.016265	.016362	.015741	.013380	.012151	.011032	.012049	.013938	248
.019022	.025288	.033474	.041023	.049113	.055231	.060453	.062275	249
.061600	.056481	.049343	.038872	.027127	.013268	.000606	-.011178	250
-.019497	-.025775	-.028522	-.030423	-.030633	-.031221	-.030324	-.029684	251
-.027447	-.025164	-.020863	-.016402	-.010722	-.006589	-.003074	-.002310	252
-.002120	-.003983	-.006294	-.010540	-.014241	-.018425	-.021017	-.023882	253
-.025539	-.027989	-.029410	-.031367	-.032036	-.033151	-.032879	-.032877	254
-.031275	-.029702	-.026310	-.022898	-.017896	-.013377	-.007945	-.003720	255
.000767	.003572	.006380	.007459	.008682	.008442	.008667	.007750	256

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MHG 97-2-12

RDE

XSTABL OUTPUT FILES

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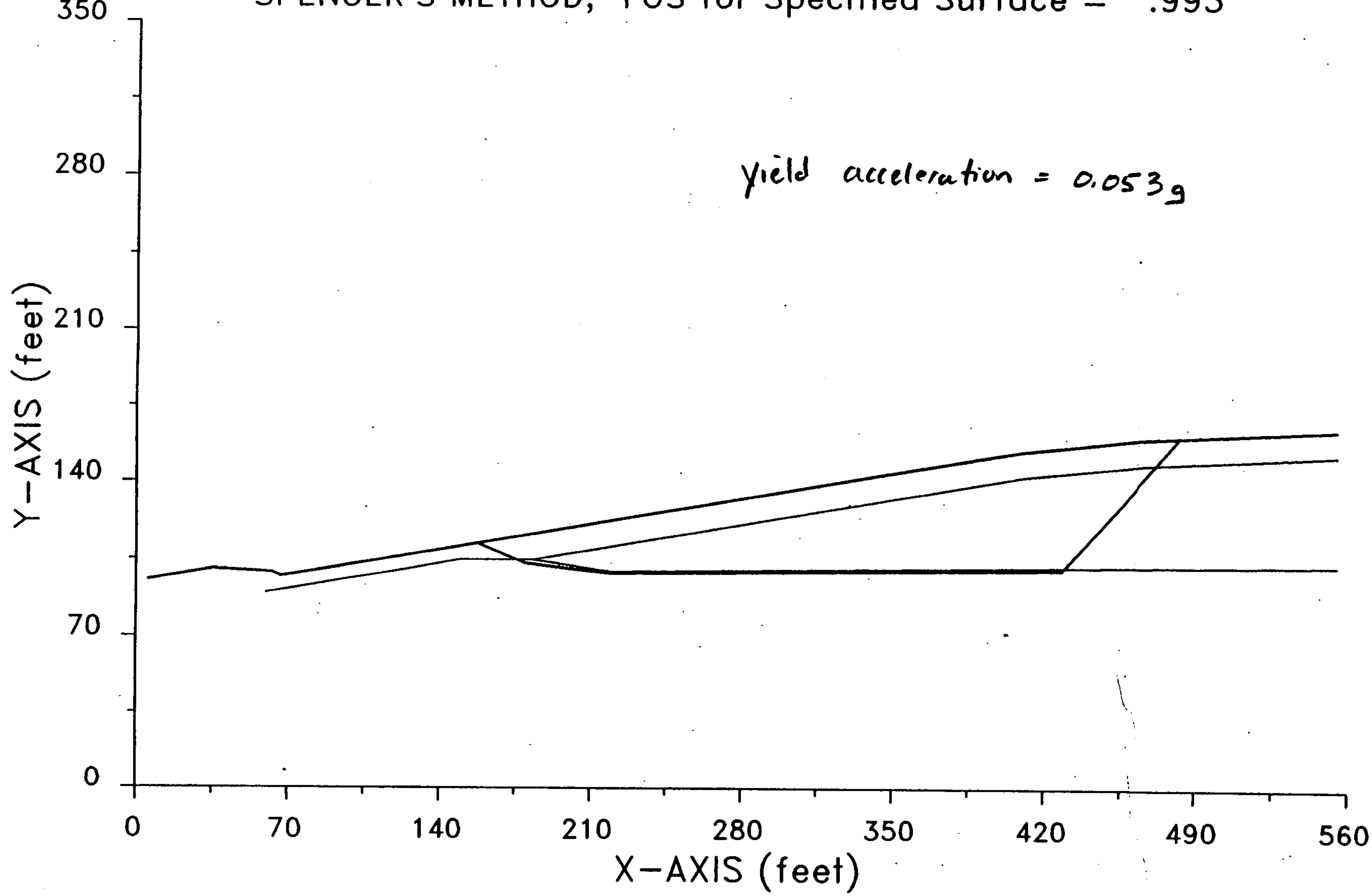
CASE7B3S 2-11-97 14:10

OSDF Final, long - 143 pcf, seismic
SPENCER'S METHOD, FOS for Specified Surface = .993



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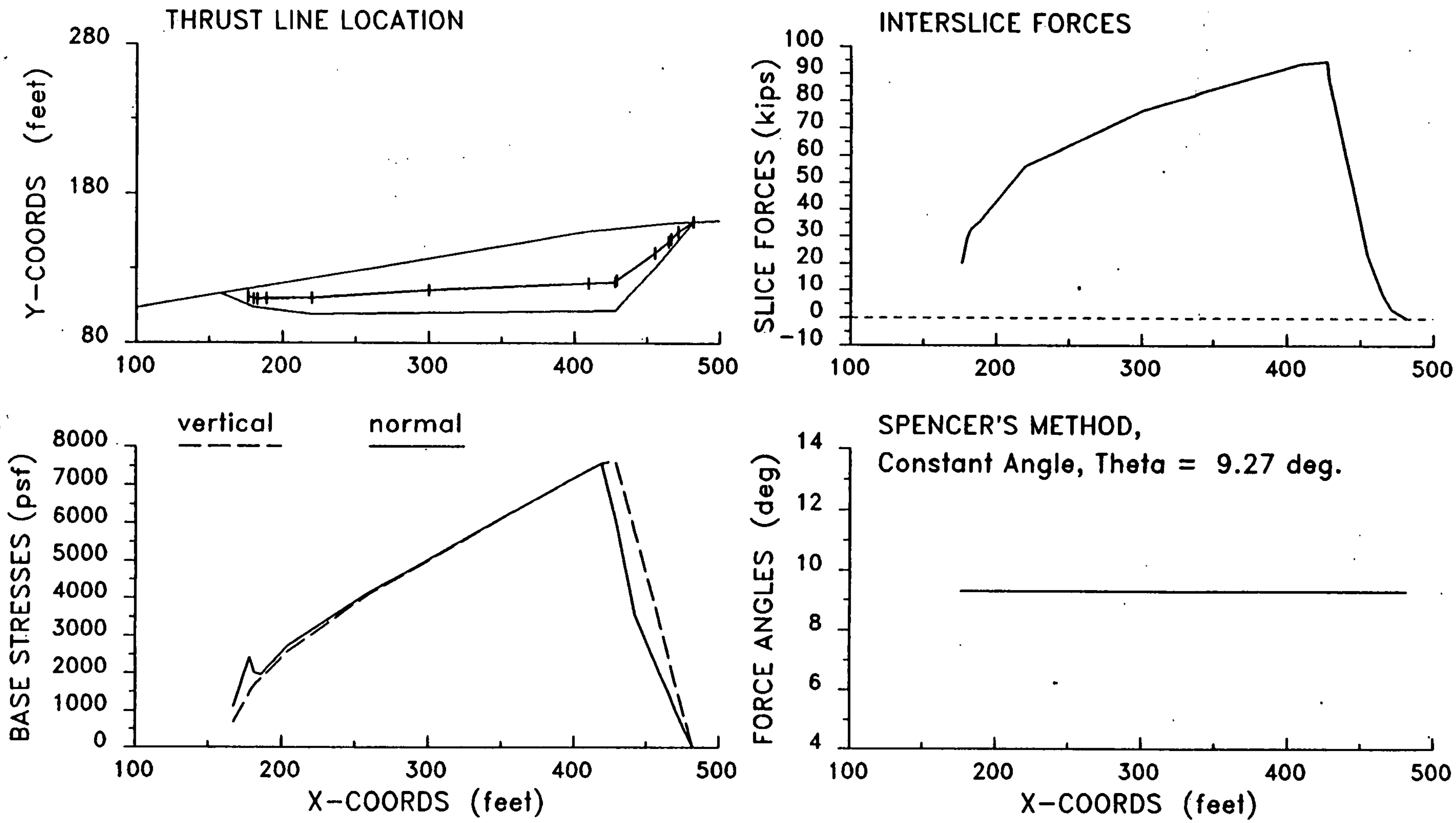

OSDF Final, long - 143 pcf, seismic

SPENCER'S METHOD, FOS for Specified Surface = .993

000157

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*********************************************
*                X S T A B L                *
*                                           *
*         Slope Stability Analysis          *
*                using the                  *
*            Method of Slices               *
*                                           *
*        Copyright (C) 1992 - 94            *
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*        Moscow, ID 83843, U.S.A.           *
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*                                           *
*  Ver. 5.100                  95 - 1305    *
*********************************************
```

Problem Description : OSDF Final, long - 143 pcf, seismic

SEGMENT BOUNDARY COORDINATES

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	5.5	95.6	35.5	100.6	2
2	35.5	100.6	62.5	99.3	2
3	62.5	99.3	67.0	97.5	2
4	67.0	97.5	410.0	154.7	2
5	410.0	154.7	465.0	160.2	2
6	465.0	160.2	555.0	164.7	2

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	60.0	90.0	120.0	100.0	2
2	120.0	100.0	150.0	105.0	2
3	150.0	105.0	183.0	105.0	2
4	183.0	105.0	189.0	106.0	1
5	189.0	106.0	410.0	142.8	1
6	410.0	142.8	467.0	148.5	1
7	467.0	148.5	555.0	152.9	1
8	183.0	105.0	220.0	100.0	6
9	220.0	100.0	300.0	100.8	5
10	300.0	100.8	410.0	102.0	4
11	410.0	102.0	555.0	103.5	3

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	125.0	125.0	.0	4.00	.000	.0	0
4	125.0	125.0	.0	5.00	.000	.0	0
5	125.0	125.0	.0	7.00	.000	.0	0
6	125.0	125.0	.0	10.00	.000	.0	0

A horizontal earthquake loading coefficient
of .053 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 7 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	157.53	112.60
2	180.25	103.47
3	220.00	99.00
4	428.25	101.18
5	455.60	130.37
6	481.96	160.45
7	482.22	161.06

SELECTED METHOD OF ANALYSIS: Spencer (1973)

SUMMARY OF INDIVIDUAL SLICE INFORMATION

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	166.99	108.80	5.38	18.91	-21.89	9.47	12707.
2	178.35	104.24	11.83	3.81	-21.89	9.47	5634.
3	181.63	103.32	13.30	2.75	-6.42	9.47	4572.
4	186.00	102.82	14.52	6.00	-6.42	9.47	10989.
5	204.50	100.74	19.69	31.00	-6.42	9.47	79907.
6	260.00	99.42	30.27	80.00	.60	9.47	327756.
7	355.00	100.41	45.11	110.00	.60	9.47	684167.
8	419.13	101.08	54.53	18.25	.60	5.71	138064.
9	428.73	101.69	54.88	.95	46.86	5.71	7278.
10	442.40	116.28	41.66	26.40	46.86	5.71	151579.
11	460.30	135.73	24.00	9.40	48.77	5.71	30243.
12	466.00	142.24	18.01	2.00	48.77	2.86	4725.
13	469.35	146.06	14.36	4.69	48.77	2.86	8642.

14	476.83	154.59	6.20	10.27	48.77	2.86	7955.
15	482.09	160.76	.30	.26	66.95	2.86	10.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	9.3280	.9936	.9878
3	9.2730	.9932	.9936

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	1099.2	.0	30.00	0.	0.	0.	.00
2	2419.8	.0	30.00	0.	0.	0.	.00
3	2006.5	.0	30.00	0.	0.	0.	.00
4	1946.7	.0	10.00	0.	0.	0.	.00
5	2739.7	.0	10.00	0.	0.	0.	.00
6	4132.5	.0	7.00	0.	0.	0.	.00
7	6239.2	.0	5.00	0.	0.	0.	.00
8	7568.1	.0	4.00	0.	0.	0.	.00
9	6106.3	.0	4.00	0.	0.	0.	.00
10	3561.0	.0	25.00	0.	0.	0.	.00
11	1938.4	.0	25.00	0.	0.	0.	.00
12	1423.4	.0	25.00	0.	0.	0.	.00
13	1109.3	.0	25.00	0.	0.	0.	.00
14	437.8	.0	30.00	0.	0.	0.	.00
15	16.5	.0	30.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	166.99	1099.2	671.9	.0	639.0
2	178.35	2419.8	1479.2	.0	1406.6
3	181.63	2006.5	1662.5	.0	1166.4
4	186.00	1946.7	1831.5	.0	345.6
5	204.50	2739.7	2577.6	.0	486.4
6	260.00	4132.5	4096.9	.0	510.9
7	355.00	6239.2	6219.7	.0	549.6
8	419.13	7568.1	7565.1	.0	532.8
9	428.73	6106.3	7625.0	.0	429.9
10	442.40	3561.0	5742.6	.0	1671.8
11	460.30	1938.4	3217.3	.0	910.1
12	466.00	1423.4	2362.5	.0	668.3
13	469.35	1109.3	1841.2	.0	520.8
14	476.83	437.8	774.9	.0	254.5
15	482.09	16.5	37.4	.0	9.6

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	176.44	9.27	20023.	5.25	10.75	.488
2	180.25	9.27	28900.	5.40	12.92	.418
3	183.00	9.27	32533.	5.46	13.68	.399
4	189.00	9.27	35375.	6.49	15.36	.423
5	220.00	9.27	56038.	10.34	24.01	.430
6	300.00	9.27	76341.	14.80	36.52	.405
7	410.00	9.27	93574.	18.68	53.71	.348
8	428.25	9.27	94548.	19.17	55.35	.346
9	429.20	9.27	88270.	19.52	54.42	.359
10	455.60	9.27	23197.	9.83	28.89	.340
11	465.00	9.27	9172.	6.59	19.10	.345
12	467.00	9.27	6981.	6.08	16.92	.359
13	471.69	9.27	2974.	5.47	11.80	.464
14	481.96	9.27	-2.	.29	.60	.483
15	482.22	.00	-11.	-.24	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 4195.99 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 673.91 (psf)

Total Length of failure surface = 353.41 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = .993

Total shear strength available along specified failure surface = 236.55E+03 lb

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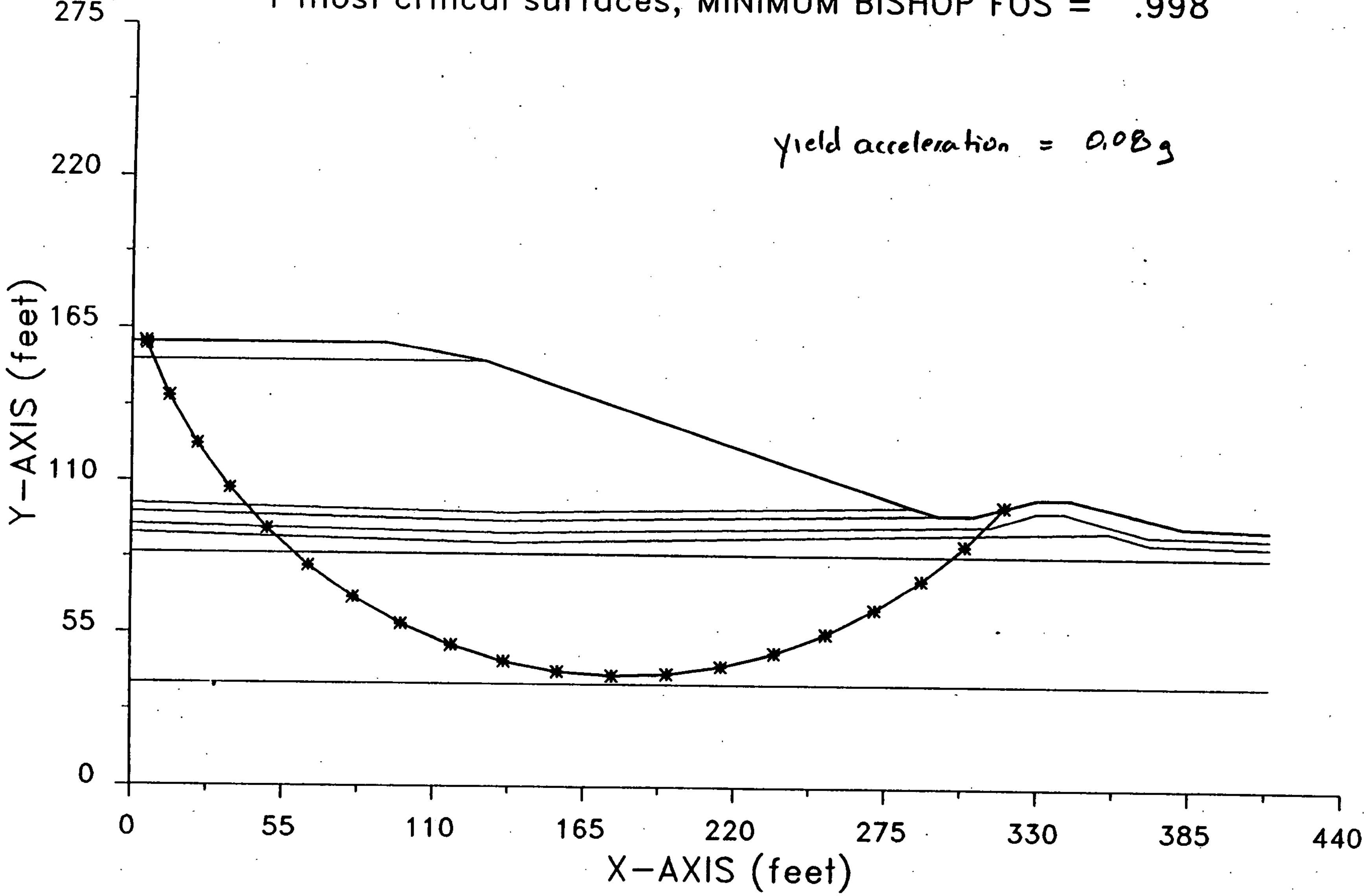
CASE1A2S 2-11-97 13:44

OSDF Interim long - 143 pcf, seismic
1 most critical surfaces, MINIMUM BISHOP FOS = .998



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*******************************************
*              X S T A B L                *
*                                         *
*        Slope Stability Analysis         *
*               using the                 *
*            Method of Slices             *
*                                         *
*        Copyright (C) 1992 - 94          *
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* Ver. 5.100                  95 - 1305   *
*******************************************
```

Problem Description : OSDF Interim long - 143 pcf, seismic

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	160.0	92.0	160.0	2
2	92.0	160.0	129.0	153.6	2
3	129.0	153.6	150.0	146.6	2
4	150.0	146.6	285.0	101.6	1
5	285.0	101.6	294.0	99.0	2
6	294.0	99.0	307.0	99.0	2
7	307.0	99.0	330.0	105.0	2
8	330.0	105.0	342.0	105.0	2
9	342.0	105.0	383.0	95.0	2
10	383.0	95.0	414.0	94.0	2

17 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	153.6	129.0	153.6	1
2	.0	101.6	136.5	98.9	1
3	136.5	98.9	285.0	101.6	1
4	.0	98.6	136.5	95.9	2
5	136.5	95.9	294.0	99.0	2
6	.0	94.2	136.5	91.5	3
7	136.5	91.5	313.0	95.0	3
8	313.0	95.0	330.0	100.0	3
9	330.0	100.0	340.0	100.0	3
10	340.0	100.0	370.0	92.0	3
11	370.0	92.0	414.0	91.0	3
12	.0	91.0	136.5	88.0	4
13	136.5	88.0	356.0	93.0	4
14	356.0	93.0	371.0	89.0	4
15	371.0	89.0	414.0	88.0	4
16	.0	84.0	414.0	84.0	5
17	.0	37.0	414.0	37.0	6

000163

ISOTROPIC Soil Parameters

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	143.0	143.0	200.0	25.00	.000	.0	0
2	125.0	125.0	.0	30.00	.000	.0	0
3	130.0	130.0	1200.0	.00	.000	.0	0
4	135.0	135.0	1200.0	.00	.000	.0	0
5	145.0	145.0	1900.0	.00	.000	.0	0
6	135.0	135.0	.0	35.00	.000	.0	0

A horizontal earthquake loading coefficient
of .080 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

400 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 20 points equally spaced
along the ground surface between x = 318.0 ft
and x = 348.0 ft

Each surface terminates between x = 5.0 ft
and x = 30.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

20.0 ft line segments define each trial failure surface.

MHG 97-2-12

ANGULAR RESTRICTIONS :

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

● ● ● ● ● SIMPLIFIED BISHOP METHOD ● ● ● ● ●

The most critical circular failure surface
is specified by 21 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	318.00	101.87
2	303.85	87.74
3	288.26	75.20
4	271.42	64.41
5	253.53	55.48
6	234.78	48.52
7	215.39	43.60
8	195.59	40.79
9	175.60	40.11
10	155.66	41.58
11	135.98	45.18
12	116.81	50.86
13	98.35	58.56
14	80.82	68.19
15	64.42	79.64
16	49.35	92.78
17	35.76	107.46
18	23.83	123.51
19	13.68	140.75
20	5.44	158.97
21	5.10	160.00

**** Simplified BISHOP FOS = .998 ****

The following is a summary of the TEN most critical surfaces

Problem Description : OSDF Interim long - 143 pcf, seismic

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	.998	179.30	226.64	186.56	318.00	5.10	1.229E+08
2.	.999	180.68	229.24	189.07	321.16	4.94	1.257E+08
3.	.999	180.58	228.38	187.67	319.58	5.87	1.236E+08
4.	1.000	192.78	242.31	205.35	344.84	4.92	1.468E+08
5.	1.001	181.71	229.38	188.40	321.16	6.64	1.243E+08
6.	1.001	182.20	229.79	189.21	322.74	6.52	1.257E+08
7.	1.002	192.07	241.74	204.07	343.26	5.33	1.448E+08
8.	1.002	183.14	232.57	192.17	325.89	5.47	1.292E+08
9.	1.002	182.98	229.96	188.75	322.74	7.77	1.246E+08
10.	1.003	182.52	233.56	192.40	324.32	4.97	1.286E+08

● ● ● END OF FILE ● ● ●

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MHG 97-2-12

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RPG

DEFORMATION ANALYSIS FILES

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PO3

FERMCO-OSDF
Seismic Deformation Analysis
Calculates the equivalent angle (θ) for input to YSLIP_C

MHG 97-2-12

Performed by : D Espinoza
11-Feb-97

$$a_{yield} = \frac{\tan\phi - \tan\theta}{1 + \tan\phi \ \tan\theta} = \tan(\phi - \theta)$$

a_{yield}	ϕ (°)	θ (°)	Comments
0.05	5.00	1.97	Failure along liner system
0.08	25.00	20.43	Failure surface within subsurface till

000164

Yslip-C input file - CASE 7B

- long term final configuration

```
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 -.082011 -.074123 -.063826 -.051989 -.040066 -.030668 -.025390 -.024108
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MHB 2-12-97

-.029530	-.024072	-.018243	-.012262	-.005409	0.002777	0.012378	0.022011
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0.032334	0.028774	0.026328	0.024872	0.024708	0.025487	0.027004	0.028565
0.030054	0.031270	0.032480	0.033421	0.034164	0.034443	0.034584	0.034750
0.035686	0.037319	0.039401	0.041385	0.043839	0.046851	0.049998	0.051749
0.051055	0.046885	0.039562	0.030001	0.019733	0.009444	0.000078	-.007573
-.012303	-.013902	-.012448	-.008939	-.004192	0.000398	0.003843	0.005129
0.004434	0.002058	-.001305	-.005276	-.008773	-.011118	-.011338	-.009181
-.004937	-.000055	0.004894	0.008997	0.011310	0.010784	0.007611	0.002302
-.003961	-.010655	-.017124	-.023156	-.027738	-.030270	-.030592	-.029762
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-.008385	-.005827	-.003170	-.001092	0.000168	0.000221	-.000500	-.001632
-.002527	-.003602	-.005055	-.006999	-.008560	-.009372	-.009408	-.009435
-.009415	-.009251	-.008630	-.008135	-.007773	-.007686	-.007668	-.007806
-.007540	-.006839	-.005440	-.003632	-.001377	0.001062	0.003844	0.006465
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0.006445	0.001069	-.005102	-.010955	-.014957	-.016862	-.016726	-.014894
-.011001	-.005562	0.000691	0.006371	0.010654	0.012804	0.012974	0.011143
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-.015543	-.013412	-.010307	-.006647	-.002815	0.000162	0.001810	0.001750
0.000383	-.002341	-.006036	-.010294	-.013899	-.016234	-.016676	-.015236
-.011444	-.005542	0.001868	0.009386	0.016081	0.020702	0.022711	0.021610
0.017716	0.011538	0.004482	-.002810	-.010016	-.017287	-.023684	-.028481
-.031148	-.032380	-.032757	-.032546	-.030912	-.027882	-.023677	-.019147
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-.003023	-.001936	-.000142	0.001602	0.002946	0.003750	0.004544	0.005019
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0.007063	0.009636	0.012639	0.015654	0.018897	0.022088	0.025095	0.027299
0.028960	0.030270	0.031651	0.032767	0.033552	0.033605	0.033224	0.032423
0.031457	0.030007	0.028231	0.026110	0.024125	0.022208	0.020750	0.019757
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-.002989	-.004357	-.004583	-.004341	-.003888	-.003747	-.003970	-.004958
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-.027211	-.030984	-.033622	-.034504	-.032797	-.028845	-.023298	-.017328
-.011263	-.005524	-.000419	0.003305	0.005768	0.006923	0.007190	0.006509
0.005267	0.003497	0.001654	-.000150	-.001365	-.001813	-.001015	0.000657
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0.010494	0.009190	0.009009	0.009132	0.009467	0.009890	0.010353	0.009963
0.008475	0.005868	0.002900	-.000174	-.002820	-.004936	-.005964	-.005856
-.004517	-.002729	-.000886	0.000499	0.001629	0.002493	0.003417	0.004127
0.004886	0.005837	0.007434	0.009129	0.010497	0.010954	0.010622	0.009213
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-.009205	-.008800	-.008025	-.006897	-.005117	-.003048	-.000911	0.000714
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-.000807	-.000799	-.000458	-.000166	0.000219	0.000660	0.001562	0.002671
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0.007284	0.006854	0.006887	0.007227	0.007949	0.008768	0.009952	0.011313
0.012677	0.013082	0.012216	0.010027	0.007378	0.004682	0.002314	-.000047
-.002082	-.003518	-.003647	-.002614	-.000728	0.000923	0.002032	0.002567
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-.005261	-.003667	-.002132	-.001273	-.001055	-.001623	-.002509	-.003552
-.004271	-.004800	-.004907	-.004747	-.004047	-.002983	-.001524	-.000294
0.000573	0.000854	0.000922	0.000620	0.000178	-.000508	-.001183	-.002003
-.002564	-.002779	-.002172	-.000865	0.001208	0.003600	0.006347	0.009073
0.011765	0.013907	0.015438	0.016132	0.016240	0.015512	0.014243	0.012546
0.010991	0.009490	0.008270	0.007135	0.006090	0.004585	0.002753	0.000568
-.001592	-.003737	-.005349	-.006392	-.006555	-.006014	-.004588	-.002701
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-.000243	-.002833	-.005368	-.007621	-.009175	-.010287	-.010893	-.011308
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0.002452	0.001377	-.000035	-.001754	-.003227	-.004443	-.005052	-.005206
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-.002976	-.002461	-.002267	-.002380	-.002425	-.002515	-.002405	-.002372
-.002336	-.002614	-.002939	-.003296	-.003344	-.003411	-.003378	-.003280
-.002737	-.002071	-.001302	-.000774	-.000303	-.000115	0.000061	0.000181
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0.004100	0.003956	0.004020	0.004212	0.004822	0.005549	0.006453	0.007138
0.007560	0.007341	0.006702	0.005513	0.004056	0.002221	0.000361	-.001568
-.003080	-.004050	-.004149	-.003783	-.003041	-.002264	-.001281	-.000431
0.000296	0.000466	0.000158	-.000711	-.001600	-.002405	-.002769	-.002881
-.002521	-.001839	-.000603	0.000897	0.002634	0.004011	0.004916	0.005098
0.004911	0.004203	0.003251	0.002075	0.001126	0.000264	-.000356	-.000950
-.001255	-.001335	-.000818	0.000017	0.001193	0.002432	0.003910	0.005263
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0.012765	0.013689	0.014388	0.014537	0.014264	0.013320	0.011992	0.010298
0.008700	0.007099	0.005726	0.004356	0.003114	0.001758	0.000566	-.000609
-.001520	-.002302	-.002676	-.002794	-.002356	-.001463	0.000105	0.001889
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-.001818	-.003500	-.004656	-.005342	-.005384	-.005155	-.004597	-.004051
-.003486	-.003289	-.003329	-.003788	-.004403	-.005307	-.006121	-.006848
-.007159	-.007277	-.007028	-.006625	-.005948	-.005327	-.004596	-.004018
-.003453	-.003098	-.002730	-.002632	-.002674	-.003099	-.003719	-.004726
-.005758	-.006737	-.007256	-.007553	-.007557	-.007551	-.007263	-.006826
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-.000913	-.000162	0.000768	0.001666	0.002708	0.003645	0.004616	0.005254
0.005582	0.005277	0.004538	0.003292	0.001993	0.000684	-.000236	-.000884
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0.003164	0.003151	0.003164	0.002937	0.002718	0.002327	0.001970	0.001469
0.001092	0.000656	0.000412	0.000158	0.000031	-.000242	-.000410	-.000626
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-.007516	-.007315	-.006699	-.005953	-.004949	-.004035	-.003156	-.002603
-.002184	-.002073	-.001938	-.001871	-.001618	-.001371	-.000906	-.000436
0.000188	0.000672	0.001138	0.001292	0.001328	0.001110	0.000924	0.000569
0.000272	-.000095	-.000257	-.000404	-.000313	-.000186	0.000215	0.000729
0.001521	0.002309	0.003311	0.004312	0.005437	0.006373	0.007188	0.007556
0.007713	0.007496	0.007077	0.006272	0.005419	0.004462	0.003777	0.003308
0.003312	0.003523	0.004060	0.004583	0.005143	0.005432	0.005655	0.005597
0.005425	0.004904	0.004272	0.003387	0.002571	0.001749	0.001256	0.000952
0.001023	0.001190	0.001608	0.002026	0.002577	0.002895	0.002993	0.002593
0.001970	0.000996	-.000025	-.001215	-.002302	-.003401	-.004168	-.004717
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-.001745	-.002175	-.002632	-.003203	-.003622	-.004090	-.004392	-.004679
-.004704	-.004716	-.004573	-.004556	-.004481	-.004511	-.004329	-.004052
-.003477	-.002919	-.002292	-.001865	-.001418	-.001169	-.000954	-.000953
-.000896	-.000925	-.000718	-.000445	0.000049	0.000520	0.001137	0.001581
0.001933	0.001944	0.001871	0.001590	0.001444	0.001311	0.001432	0.001656
0.002260	0.003005	0.003978	0.004875	0.005836	0.006563	0.007184	0.007400
0.007320	0.006712	0.005864	0.004619	0.003224	0.001577	0.000072	-.001328
-.002317	-.003063	-.003389	-.003615	-.003640	-.003710	-.003604	-.003528
-.003262	-.002990	-.002479	-.001949	-.001274	-.000783	-.000365	-.000275
-.000252	-.000473	-.000748	-.001253	-.001692	-.002190	-.002498	-.002838
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-.003717	-.003530	-.003127	-.002721	-.002127	-.001590	-.000944	-.000442
0.000091	0.000424	0.000758	0.000886	0.001032	0.001003	0.001030	0.000921

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MHb 97-2-12

Yslip-C input file CASE 1A25.

interm - long term

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0. 1 1
2040 255 16320 .025 1
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-.007516	-.007315	-.006699	-.005953	-.004949	-.004035	-.003156	-.002603
-.002184	-.002073	-.001938	-.001871	-.001618	-.001371	-.000906	-.000436
0.000188	0.000672	0.001138	0.001292	0.001328	0.001110	0.000924	0.000569
0.000272	-.000095	-.000257	-.000404	-.000313	-.000186	0.000215	0.000729
0.001521	0.002309	0.003311	0.004312	0.005437	0.006373	0.007188	0.007556
0.007713	0.007496	0.007077	0.006272	0.005419	0.004462	0.003777	0.003308
0.003312	0.003523	0.004060	0.004583	0.005143	0.005432	0.005655	0.005597
0.005425	0.004904	0.004272	0.003387	0.002571	0.001749	0.001256	0.000952
0.001023	0.001190	0.001608	0.002026	0.002577	0.002895	0.002993	0.002593
0.001970	0.000996	-.000025	-.001215	-.002302	-.003401	-.004168	-.004717
-.004800	-.004647	-.004151	-.003634	-.002952	-.002390	-.001855	-.001689
-.001745	-.002175	-.002632	-.003203	-.003622	-.004090	-.004392	-.004679
-.004704	-.004716	-.004573	-.004556	-.004481	-.004511	-.004329	-.004052
-.003477	-.002919	-.002292	-.001865	-.001418	-.001169	-.000954	-.000953
-.000896	-.000925	-.000718	-.000445	0.000049	0.000520	0.001137	0.001581
0.001933	0.001944	0.001871	0.001590	0.001444	0.001311	0.001432	0.001656
0.002260	0.003005	0.003978	0.004875	0.005836	0.006563	0.007184	0.007400
0.007320	0.006712	0.005864	0.004619	0.003224	0.001577	0.000072	-.001328
-.002317	-.003063	-.003389	-.003615	-.003640	-.003710	-.003604	-.003528
-.003262	-.002990	-.002479	-.001949	-.001274	-.000783	-.000365	-.000275
-.000252	-.000473	-.000748	-.001253	-.001692	-.002190	-.002498	-.002838
-.003035	-.003326	-.003495	-.003728	-.003807	-.003940	-.003907	-.003907
-.003717	-.003530	-.003127	-.002721	-.002127	-.001590	-.000944	-.000442
0.000091	0.000424	0.000758	0.000886	0.001032	0.001003	0.001030	0.000921

FERMCO - OSDF
SEISMIC DEFORMATION ANALYSIS
LINER SYSTEM

Time (s)	Sliding Acc	Velocity	Disp. (in)
.000000	.000000	.000000	.000000
3.664483	.000000	.000000	.000000
3.675000	2.046439	.010761	.000015
3.700000	3.945356	.085658	.000450
3.725000	2.137795	.161698	.001705
3.750000	-1.771052	.166282	.003399
3.775000	-5.358663	.077161	.004671
3.788083	-5.923119	.000000	.004881
3.788083	.000000	.000000	.004881
3.878236	.000000	.000000	.004881
3.900000	2.265495	.024654	.004952
3.925000	4.804915	.113034	.005577
3.950000	6.354105	.252521	.007344
3.975000	5.437548	.399917	.010574
4.000000	1.360709	.484895	.015012
4.025000	-6.552278	.420001	.019627
4.050000	-17.498813	.119362	.022506
4.054958	-20.107517	.000000	.022650
4.054958	.000000	.000000	.022650
5.101179	.000000	.000000	.022650
5.125000	16.457721	.196023	.023263
5.150000	29.344416	.768550	.027746
5.175000	34.791619	1.570250	.039144
5.200000	30.997664	2.392616	.058724
5.225000	17.294544	2.996269	.085525
5.250000	-4.188942	3.160089	.116263
5.275000	-28.827791	2.747380	.145840
5.300000	-51.099115	1.748293	.168421
5.325000	-68.693354	.250887	.178620
5.328335	-70.438504	.000000	.178798
5.328335	.000000	.000000	.178798
6.301073	.000000	.000000	.178798
6.325000	16.465189	.196985	.179417
6.350000	28.102311	.754079	.183859
6.375000	33.559338	1.524850	.194962
6.400000	33.233144	2.359756	.214086
6.425000	27.359497	3.117164	.241159
6.450000	16.377520	3.663876	.274756
6.475000	.831450	3.878989	.312195
6.500000	-17.100791	3.675622	.349741
6.525000	-35.964306	3.012308	.383041
6.550000	-55.393643	1.870334	.407468
6.575000	-75.126498	.238832	.418252
6.577843	-77.149198	.000000	.418399
6.577843	.000000	.000000	.418399
7.000264	.000000	.000000	.418399
7.025000	3.209498	.039695	.418528
7.050000	.683828	.088361	.419210
7.075000	-5.861692	.023638	.419895
7.077513	-6.574456	.000000	.419911
7.077513	.000000	.000000	.419911
7.356246	.000000	.000000	.419911
7.375000	4.470855	.041922	.420014
7.400000	6.840324	.183312	.421074
7.425000	5.010166	.331443	.423645
7.450000	-1.152238	.379667	.427271
7.475000	-12.014290	.215085	.430420
7.486233	-18.424394	.000000	.431020
7.486233	.000000	.000000	.431020
9.296852	.000000	.000000	.431020
9.300000	2.896091	.004559	.431022
9.325000	23.404986	.333323	.432264
9.350000	38.445025	1.106448	.439041
9.375000	45.551436	2.156404	.454953
9.400000	44.511041	3.282185	.481739
9.425000	35.781624	4.285843	.519162
9.450000	21.474300	5.001542	.565161
9.475000	4.278800	5.323456	.616326
9.500000	-13.115139	5.213002	.668535
9.525000	-28.498163	4.692835	.717600
9.550000	-39.669758	3.840736	.759825
9.575000	-46.905962	2.758540	.792450
9.600000	-51.724530	1.525658	.813632
9.625000	-54.785610	.194282	.822160
9.628562	-54.716888	.000000	.822295
9.628562	.000000	.000000	.822295
9.817227	.000000	.000000	.822295
9.825000	2.137706	.008308	.822304
9.850000	8.908185	.146382	.822926
9.875000	13.543973	.427034	.825653
9.900000	13.552800	.765743	.831523
9.925000	6.949300	1.022020	.840456
9.950000	-6.069067	1.033022	.850837
9.975000	-22.747733	.672812	.859573
9.996760	-36.972688	.000000	.862775
9.996760	.000000	.000000	.862775
14.499380	.000000	.000000	.862775
14.500000	.380149	.000118	.862775
14.525000	11.250049	.145495	.863269
14.550000	15.952638	.485529	.866278
14.575000	15.390707	.877321	.872996
14.600000	12.394458	1.224635	.883402
14.625000	7.714423	1.475996	.896788
14.650000	.141310	1.574193	.911955
14.675000	-12.203164	1.423420	.926960
14.700000	-28.914256	.909452	.938783
14.723880	-46.431795	.000000	.943432
14.723880	.000000	.000000	.943432
15.685063	.000000	.000000	.943432
15.700000	7.525692	.056205	.943542
15.725000	15.765790	.347348	.945359
15.750000	19.047868	.782519	.950852
15.775000	17.485878	1.239191	.960834
15.800000	11.858839	1.606000	.974951
15.825000	2.206048	1.781811	.991821
15.850000	-10.196391	1.681932	1.009122
15.875000	-22.551671	1.272581	1.023915
15.900000	-30.685702	.607114	1.033332
15.919327	-31.809695	.000000	1.035668
15.919327	.000000	.000000	1.035668
16.028000	.000000	.000000	1.035668
16.050000	10.162136	.111785	1.035991
16.075000	20.051628	.489457	1.038747
16.100000	26.090225	1.066230	1.046279
16.125000	26.851526	1.728002	1.060014
16.150000	23.922054	2.362672	1.080206
16.175000	20.537731	2.918419	1.106265
16.200000	18.594528	3.407572	1.137436
16.225000	16.539325	3.846746	1.173179
16.250000	13.530232	4.222615	1.212952
16.275000	9.922868	4.515779	1.256030
16.300000	6.342023	4.719090	1.301550
16.325000	3.243516	4.838909	1.348651
16.350000	1.838610	4.902436	1.396620
16.375000	.861032	4.936181	1.445058
16.400000	-2.050828	4.921309	1.493629
16.425000	-8.453039	4.790011	1.541553

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16.450000	-17.508621	4.465490	1.587287
16.475000	-28.297089	3.892918	1.628642
16.500000	-39.446068	3.046129	1.663020
16.525000	-49.886736	1.929469	1.687720
16.550000	-59.023771	.568087	1.700198
16.559060	-61.691633	.000000	1.701257
16.559060	.000000	.000000	1.701257
18.638506	.000000	.000000	1.701257
18.650000	3.897875	.022402	1.701290
18.675000	11.282332	.212154	1.702293
18.700000	17.738444	.574914	1.706034
18.725000	21.962607	1.071177	1.714048
18.750000	22.943959	1.632509	1.727334
18.775000	20.899604	2.180554	1.746141
18.800000	17.590929	2.661686	1.770039
18.825000	14.167306	3.058663	1.798260
18.850000	11.069820	3.374128	1.829981
18.875000	7.036131	3.600452	1.864388
18.900000	.953219	3.700319	1.900441
18.925000	-7.881306	3.613718	1.936617
18.950000	-18.776833	3.280491	1.970768
18.975000	-31.372828	2.653620	2.000230
19.000000	-44.878476	1.700479	2.021934
19.025000	-58.245582	.411428	2.032602
19.031438	-61.160236	.000000	2.033161
19.031438	.000000	.000000	2.033161
19.265144	.000000	.000000	2.033161
19.275000	6.465936	.031863	2.033203
19.300000	18.981298	.349953	2.034825
19.325000	26.820579	.922477	2.040926
19.350000	29.664503	1.628541	2.053422
19.375000	26.967854	2.336445	2.072990
19.400000	19.346579	2.915375	2.098992
19.425000	8.271287	3.260599	2.129613
19.450000	-4.310963	3.310103	2.162207
19.475000	-17.831370	3.033324	2.193702
19.500000	-31.436250	2.417478	2.220806
19.525000	-44.640305	1.466521	2.240190
19.550000	-56.465088	.202704	2.248648
19.553297	-57.787987	.000000	2.248789
19.553297	.000000	.000000	2.248789
22.020982	.000000	.000000	2.248789
22.025000	1.863003	.003743	2.248791
22.050000	7.714967	.123468	2.249297
22.075000	6.786624	.304738	2.251423
22.100000	.459184	.395310	2.254998
22.125000	-8.927349	.289458	2.258561
22.146012	-17.077458	.000000	2.259943
22.146012	.000000	.000000	2.259943
24.193288	.000000	.000000	2.259943
24.200000	2.962245	.009941	2.259952
24.225000	11.842848	.195004	2.260778
24.250000	17.791076	.565429	2.264399
24.275000	20.387455	1.042660	2.272259
24.300000	20.707675	1.556349	2.285043
24.325000	19.111282	2.054086	2.302844
24.350000	15.368405	2.485082	2.325259
24.375000	9.131286	2.791329	2.351353
24.400000	1.436328	2.923424	2.379635
24.425000	-6.833316	2.855961	2.408246
24.450000	-14.769933	2.585921	2.435190
24.475000	-22.224199	2.123494	2.458519
24.500000	-28.945604	1.483871	2.476410
24.525000	-35.311374	.680659	2.487193
24.542846	-39.351262	.000000	2.489677
24.542846	.000000	.000000	2.489677

50.975000	.000000	.000000	2.489677

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1033

0001740

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FERMCO - OSDF
SEISMIC DEFORMATION ANALYSIS
Foundation

Time (s)	Sliding Acc	Velocity	Disp. (in)
.000000	.000000	.000000	.000000
5.144860	.000000	.000000	.000000
5.150000	2.907225	.007472	.000005
5.175000	8.883943	.154862	.000681
5.200000	4.721251	.324927	.003128
5.225000	-10.313792	.255020	.006290
5.236540	-21.194054	.000000	.007083
5.236540	.000000	.000000	.007083
6.346975	.000000	.000000	.007083
6.350000	1.544794	.002336	.007084
6.375000	7.532291	.115800	.007543
6.400000	7.174437	.299634	.009595
6.425000	.729917	.398438	.013162
6.450000	-11.319461	.266069	.016680
6.463405	-20.465700	.000000	.017576
6.463405	.000000	.000000	.017576
9.330467	.000000	.000000	.017576
9.350000	12.893526	.125926	.017898
9.375000	20.690738	.545730	.021044
9.400000	19.549266	1.048730	.028914
9.425000	9.971390	1.417738	.041249
9.450000	-5.726567	1.470798	.055786
9.475000	-24.593420	1.091798	.068784
9.500000	-43.677984	.238406	.075721
9.504574	-46.766305	.000000	.075967
9.504574	.000000	.000000	.075967
16.119773	.000000	.000000	.075967
16.125000	.174647	.000456	.075967
16.125319	.133681	.000000	.075967
16.125319	.000000	.000000	.075967
16.150000	.000000	.000000	.075856
19.324583	.000000	.000000	.075856
19.325000	.143390	.000030	.075856
19.350000	3.263787	.042620	.076002
19.375000	.305066	.087230	.076702
19.397506	-7.222608	.000000	.077255
19.397506	.000000	.000000	.077255
50.975000	.000000	.000000	.077255

000172

MHG 2-12-97

FERMCO - OSDF
Liner and Foundation Accel@ration
=>
Max = 0.0993
Min = -0.08848

Time (sec)	Shear (ksf)	Accelation [-]
0.00000	0.00133	0.00016
0.00250	0.00088	0.00011
0.00500	0.00132	0.00016
0.00750	0.00088	0.00010
0.01000	0.00132	0.00016
0.01250	0.00088	0.00010
0.01500	0.00131	0.00016
0.01750	0.00087	0.00010
0.02000	0.00130	0.00015
0.02250	0.00085	0.00010
0.02500	0.00128	0.00015
0.02750	0.00082	0.00010
0.03000	0.00125	0.00015
0.03250	0.00077	0.00009
0.03500	0.00118	0.00014
0.03750	0.00067	0.00008
0.04000	0.00102	0.00012
0.04250	0.00041	0.00005
0.04500	0.00058	0.00007
0.04750	-0.00025	-0.00003
0.05000	-0.00035	-0.00004
0.05250	-0.00148	-0.00018
0.05500	-0.00187	-0.00022
0.05750	-0.00327	-0.00039
0.06000	-0.00396	-0.00047
0.06250	-0.00568	-0.00068
0.06500	-0.00662	-0.00079
0.06750	-0.00847	-0.00101
0.07000	-0.00929	-0.00110
0.07250	-0.01070	-0.00127
0.07500	-0.01080	-0.00128
0.07750	-0.01135	-0.00135
0.08000	-0.01077	-0.00128
0.08250	-0.01096	-0.00130
0.08500	-0.01009	-0.00120
0.08750	-0.00978	-0.00116
0.09000	-0.00833	-0.00099
0.09250	-0.00786	-0.00093
0.09500	-0.00708	-0.00084
0.09750	-0.00802	-0.00095
0.10000	-0.00889	-0.00106
0.10250	-0.01130	-0.00134
0.10500	-0.01346	-0.00160
0.10750	-0.01736	-0.00206
0.11000	-0.02122	-0.00252
0.11250	-0.02641	-0.00314
0.11500	-0.03037	-0.00361
0.11750	-0.03407	-0.00405
0.12000	-0.03509	-0.00417
0.12250	-0.03484	-0.00414
0.12500	-0.03158	-0.00375
0.12750	-0.02755	-0.00327
0.13000	-0.02174	-0.00258
0.13250	-0.01649	-0.00196
0.13500	-0.01084	-0.00129
0.13750	-0.00784	-0.00093
0.14000	-0.00703	-0.00084
0.14250	-0.01044	-0.00124
0.14500	-0.01536	-0.00183
0.14750	-0.02201	-0.00262
0.15000	-0.02739	-0.00326
0.15250	-0.03289	-0.00391
0.15500	-0.03648	-0.00434
0.15750	-0.03867	-0.00460
0.16000	-0.03609	-0.00429
0.16250	-0.02998	-0.00356
0.16500	-0.02001	-0.00238
0.16750	-0.01059	-0.00126
0.17000	-0.00277	-0.00033
0.17250	-0.00113	-0.00013
0.17500	-0.00609	-0.00072
0.17750	-0.01940	-0.00231
0.18000	-0.03621	-0.00430
0.18250	-0.05397	-0.00641
0.18500	-0.06751	-0.00802
0.18750	-0.07618	-0.00905
0.19000	-0.07761	-0.00922
0.19250	-0.07427	-0.00883
0.19500	-0.06409	-0.00762
0.19750	-0.04802	-0.00571
0.20000	-0.02632	-0.00313
0.20250	-0.00504	-0.00060
0.20500	0.01588	0.00189
0.20750	0.03395	0.00403
0.21000	0.04918	0.00584
0.21250	0.06055	0.00720
0.21500	0.07164	0.00851
0.21750	0.08122	0.00965
0.22000	0.09156	0.01088
0.22250	0.10127	0.01204
0.22500	0.11147	0.01325
0.22750	0.11818	0.01404
0.23000	0.12100	0.01438
0.23250	0.11877	0.01411
0.23500	0.11503	0.01367
0.23750	0.10826	0.01287
0.24000	0.10031	0.01192
0.24250	0.09060	0.01077
0.24500	0.08292	0.00985
0.24750	0.07823	0.00930
0.25000	0.08037	0.00955
0.25250	0.08629	0.01025
0.25500	0.09315	0.01107
0.25750	0.09550	0.01135
0.26000	0.09139	0.01086
0.26250	0.07583	0.00901
0.26500	0.05239	0.00623
0.26750	0.02316	0.00275
0.27000	-0.00815	-0.00097
0.27250	-0.04265	-0.00507
0.27500	-0.07878	-0.00936
0.27750	-0.11773	-0.01399
0.28000	-0.15352	-0.01824
0.28250	-0.18220	-0.02165
0.28500	-0.19862	-0.02360
0.28750	-0.20406	-0.02425
0.29000	-0.19695	-0.02341
0.29250	-0.17977	-0.02136
0.29500	-0.15516	-0.01844
0.29750	-0.13192	-0.01568
0.30000	-0.11344	-0.01348
0.30250	-0.10219	-0.01214
0.30500	-0.09508	-0.01130
0.30750	-0.09241	-0.01098
0.31000	-0.08745	-0.01039
0.31250	-0.07795	-0.00926
0.31500	-0.06395	-0.00760
0.31750	-0.04798	-0.00570
0.32000	-0.02837	-0.00337
0.32250	-0.01240	-0.00147
0.32500	-0.00575	-0.00068
0.32750	-0.01787	-0.00212
0.33000	-0.05025	-0.00597
0.33250	-0.09846	-0.01170
0.33500	-0.15320	-0.01821
0.33750	-0.20988	-0.02494
0.34000	-0.25736	-0.03058
0.34250	-0.28715	-0.03412
0.34500	-0.28942	-0.03439
0.34750	-0.25955	-0.03084
0.35000	-0.19095	-0.02269
0.35250	-0.08628	-0.01025
0.35500	0.04400	0.00523
0.35750	0.17436	0.02072
0.36000	0.28268	0.03359
0.36250	0.36143	0.04295
0.36500	0.42129	0.05006
0.36750	0.46296	0.05502
0.37000	0.47923	0.05695
0.37250	0.46374	0.05511
0.37500	0.43026	0.05113
0.37750	0.39953	0.04748
0.38000	0.39029	0.04638
0.38250	0.40124	0.04768
0.38500	0.42222	0.05018
0.38750	0.44254	0.05259
0.39000	0.46484	0.05524
0.39250	0.48659	0.05782
0.39500	0.49986	0.05940
0.39750	0.49201	0.05847
0.40000	0.45709	0.05432
0.40250	0.38930	0.04626
0.40500	0.29553	0.03512
0.40750	0.18285	0.02173
0.41000	0.05919	0.00703
0.41250	-0.06490	-0.00771
0.41500	-0.16557	-0.01968
0.41750	-0.23110	-0.02746
0.42000	-0.26418	-0.03139
0.42250	-0.27428	-0.03259
0.42500	-0.26489	-0.03148
0.42750	-0.23738	-0.02821
0.43000	-0.18773	-0.02231
0.43250	-0.12919	-0.01535
0.43500	-0.08164	-0.00970
0.43750	-0.06139	-0.00730
0.44000	-0.06689	-0.00795
0.44250	-0.09255	-0.01100
0.44500	-0.12279	-0.01459
0.44750	-0.14519	-0.01725
0.45000	-0.15781	-0.01875
0.45250	-0.17157	-0.02039
0.45500	-0.19270	-0.02290
0.45750	-0.22171	-0.02635
0.46000	-0.24398	-0.02899
0.46250	-0.25051	-0.02977
0.46500	-0.24363	-0.02895
0.46750	-0.24566	-0.02919
0.47000	-0.27113	-0.03222
0.47250	-0.31151	-0.03702
0.47500	-0.34130	-0.04056
0.47750	-0.34779	-0.04133
0.48000	-0.32837	-0.03902
0.48250	-0.29331	-0.03486
0.48500	-0.25157	-0.02990
0.48750	-0.21441	-0.02548
0.49000	-0.18463	-0.02194
0.49250	-0.16171	-0.01922
0.49500	-0.13746	-0.01634
0.49750	-0.10463	-0.01243
0.50000	-0.05223	-0.00621
0.50250	0.02647	0.00315
0.50500	0.13826	0.01643
0.50750	0.27963	0.03323
0.51000	0.43846	0.05210
0.51250	0.58641	0.06969
0.51500	0.69680	0.08280
0.51750	0.74346	0.08835
0.52000	0.71096	0.08449
0.52250	0.59358	0.07054
0.52500	0.40955	0.04867
0.52750	0.19849	0.02359
0.53000	0.00772	0.00092
0.53250	-0.14300	-0.01699
0.53500	-0.25507	-0.03031
0.53750	-0.33445	-0.03974
0.54000	-0.36996	-0.04396
0.54250	-0.35531	-0.04222
0.54500	-0.29926	-0.03556
0.54750	-0.23146	-0.02751
0.55000	-0.17661	-0.02099
0.55250	-0.14396	-0.01711
0.55500	-0.12570	-0.01494
0.55750	-0.11787	-0.01401
0.56000	-0.11962	-0.01422
0.56250	-0.13414	-0.01594
0.56500	-0.15574	-0.01851
0.56750	-0.18066	-0.02147
0.57000	-0.19767	-0.02349
0.57250	-0.19324	-0.02296
0.57500	-0.15401	-0.01830
0.57750	-0.08707	-0.01035
0.58000	-0.00858	-0.00102
0.58250	0.06836	0.00812
0.58500	0.14426	0.01714
0.58750	0.20790	0.02471
0.59000	0.24184	0.02874
0.59250	0.23082	0.02743
0.59500	0.16726	0.01988
0.59750	0.04605	0.00547
0.60000	-0.11433	-0.01359
0.60250	-0.28916	-0.03436
0.60500	-0.45602	-0.05419
0.60750	-0.59930	-0.07122
0.61000	-0.70041	-0.08323
0.61250	-0.74454	-0.08848
0.61500	-0.71629	-0.08512
0.61750	-0.60984	-0.07247
0.62000	-0.42938	-0.05103
0.62250	-0.20580	-0.02446
0.62500	0.02822	0.00335
0.62750	0.24839	0.02952
0.63000	0.43911	0.05218
0.63250	0.58648	0.06969
0.63500	0.68616	0.08154
0.63750	0.73290	0.08710

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0.64000	0.73011	0.08676	0.80500	-0.25283	-0.03005	0.97000	0.08540	0.01015	1.13500	0.30644	0.03642
0.64250	0.67980	0.08078	0.80750	-0.24959	-0.02966	0.97250	0.16831	0.02000	1.13750	0.33800	0.04017
0.64500	0.58573	0.06961	0.81000	-0.23880	-0.02838	0.97500	0.25831	0.03070	1.14000	0.36171	0.04298
0.64750	0.45256	0.05378	0.81250	-0.21080	-0.02505	0.97750	0.33873	0.04025	1.14250	0.34779	0.04133
0.65000	0.29895	0.03553	0.81500	-0.16073	-0.01910	0.98000	0.40486	0.04811	1.14500	0.29293	0.03481
0.65250	0.13737	0.01632	0.81750	-0.10156	-0.01207	0.98250	0.46376	0.05511	1.14750	0.21280	0.02529
0.65500	-0.02907	-0.00345	0.82000	-0.04537	-0.00539	0.98500	0.52176	0.06200	1.15000	0.12727	0.01512
0.65750	-0.19810	-0.02354	0.82250	-0.00480	-0.00057	0.98750	0.56147	0.06672	1.15250	0.03846	0.00457
0.66000	-0.35048	-0.04165	0.82500	0.01070	0.00127	0.99000	0.56154	0.06673	1.15500	-0.05577	-0.00663
0.66250	-0.47048	-0.05591	0.82750	-0.00420	-0.00050	0.99250	0.50498	0.06001	1.15750	-0.14880	-0.01768
0.66500	-0.55036	-0.06540	0.83000	-0.04059	-0.00482	0.99500	0.39346	0.04676	1.16000	-0.21246	-0.02525
0.66750	-0.59441	-0.07064	0.83250	-0.10180	-0.01210	0.99750	0.25059	0.02978	1.16250	-0.22990	-0.02732
0.67000	-0.60743	-0.07218	0.83500	-0.19802	-0.02353	1.00000	0.11060	0.01314	1.16500	-0.19687	-0.02340
0.67250	-0.59537	-0.07075	0.83750	-0.32850	-0.03904	1.00250	-0.02862	-0.00340	1.16750	-0.11677	-0.01388
0.67500	-0.56094	-0.06666	0.84000	-0.46707	-0.05550	1.00500	-0.18552	-0.02205	1.17000	0.00581	0.00069
0.67750	-0.51479	-0.06118	0.84250	-0.58814	-0.06989	1.00750	-0.36227	-0.04305	1.17250	0.15191	0.01805
0.68000	-0.45415	-0.05397	0.84500	-0.67317	-0.08000	1.01000	-0.52994	-0.06298	1.17500	0.29117	0.03460
0.68250	-0.36683	-0.04359	0.84750	-0.71510	-0.08498	1.01250	-0.65788	-0.07818	1.17750	0.38904	0.04623
0.68500	-0.24476	-0.02909	0.85000	-0.70913	-0.08427	1.01500	-0.72534	-0.08620	1.18000	0.43076	0.05119
0.68750	-0.10210	-0.01213	0.85250	-0.65852	-0.07826	1.01750	-0.73119	-0.08689	1.18250	0.41367	0.04916
0.69000	0.04086	0.00486	0.85500	-0.56349	-0.06696	1.02000	-0.69012	-0.08201	1.18500	0.34738	0.04128
0.69250	0.16533	0.01965	0.85750	-0.43409	-0.05159	1.02250	-0.62375	-0.07412	1.18750	0.23416	0.02783
0.69500	0.27399	0.03256	0.86000	-0.29031	-0.03450	1.02500	-0.53710	-0.06383	1.19000	0.07902	0.00939
0.69750	0.37123	0.04412	0.86250	-0.16376	-0.01946	1.02750	-0.43749	-0.05199	1.19250	-0.10053	-0.01195
0.70000	0.44515	0.05290	0.86500	-0.07303	-0.00868	1.03000	-0.33716	-0.04007	1.19500	-0.26947	-0.03202
0.70250	0.47293	0.05620	0.86750	-0.02667	-0.00317	1.03250	-0.25807	-0.03067	1.19750	-0.40157	-0.04772
0.70500	0.45130	0.05363	0.87000	-0.02523	-0.00300	1.03500	-0.21366	-0.02539	1.20000	-0.48498	-0.05763
0.70750	0.39523	0.04697	0.87250	-0.05936	-0.00705	1.03750	-0.20287	-0.02411	1.20250	-0.52455	-0.06234
0.71000	0.33448	0.03975	0.87500	-0.10486	-0.01246	1.04000	-0.20175	-0.02398	1.20500	-0.51757	-0.06151
0.71250	0.28412	0.03376	0.87750	-0.14310	-0.01701	1.04250	-0.18289	-0.02173	1.20750	-0.46442	-0.05519
0.71500	0.24345	0.02893	0.88000	-0.16111	-0.01915	1.04500	-0.13249	-0.01575	1.21000	-0.37765	-0.04488
0.71750	0.20677	0.02457	0.88250	-0.15831	-0.01881	1.04750	-0.06653	-0.00791	1.21250	-0.27764	-0.03299
0.72000	0.18208	0.02164	0.88500	-0.13321	-0.01583	1.05000	-0.00307	-0.00037	1.21500	-0.17505	-0.02080
0.72250	0.17422	0.02070	0.88750	-0.08657	-0.01029	1.05250	0.05090	0.00605	1.21750	-0.07893	-0.00938
0.72500	0.18675	0.02219	0.89000	-0.01872	-0.00223	1.05500	0.10024	0.01191	1.22000	0.00634	0.00075
0.72750	0.22231	0.02642	0.89250	0.06099	0.00725	1.05750	0.14157	0.01682	1.22250	0.07432	0.00883
0.73000	0.28482	0.03385	0.89500	0.14370	0.01708	1.06000	0.16716	0.01986	1.22500	0.11966	0.01422
0.73250	0.36049	0.04284	0.89750	0.21002	0.02496	1.06250	0.16656	0.01979	1.22750	0.12140	0.01443
0.73500	0.43268	0.05142	0.90000	0.24287	0.02886	1.06500	0.14112	0.01677	1.23000	0.06991	0.00831
0.73750	0.48374	0.05749	0.90250	0.23304	0.02769	1.06750	0.09901	0.01177	1.23250	-0.02242	-0.00266
0.74000	0.50403	0.05990	0.90500	0.18485	0.02197	1.07000	0.06245	0.00742	1.23500	-0.12899	-0.01533
0.74250	0.48836	0.05803	0.90750	0.10110	0.01201	1.07250	0.04500	0.00535	1.23750	-0.23148	-0.02751
0.74500	0.43557	0.05176	0.91000	-0.00858	-0.00102	1.07500	0.05026	0.00597	1.24000	-0.31631	-0.03759
0.74750	0.34252	0.04070	0.91250	-0.12308	-0.01463	1.07750	0.06711	0.00798	1.24250	-0.38404	-0.04564
0.75000	0.22032	0.02618	0.91500	-0.20899	-0.02484	1.08000	0.07598	0.00903	1.24500	-0.44315	-0.05266
0.75250	0.09023	0.01072	0.91750	-0.24066	-0.02860	1.08250	0.05577	0.00663	1.24750	-0.50291	-0.05976
0.75500	-0.01411	-0.00168	0.92000	-0.19714	-0.02343	1.08500	0.00537	0.00064	1.25000	-0.55242	-0.06565
0.75750	-0.07120	-0.00846	0.92250	-0.08270	-0.00983	1.08750	-0.06587	-0.00783	1.25250	-0.57844	-0.06874
0.76000	-0.07509	-0.00892	0.92500	0.08223	0.00977	1.09000	-0.14617	-0.01737	1.25500	-0.57357	-0.06816
0.76250	-0.03708	-0.00441	0.92750	0.27326	0.03247	1.09250	-0.23048	-0.02739	1.25750	-0.54113	-0.06431
0.76500	0.03368	0.00400	0.93000	0.47025	0.05588	1.09500	-0.30668	-0.03644	1.26000	-0.49031	-0.05827
0.76750	0.12421	0.01476	0.93250	0.64593	0.07676	1.09750	-0.36258	-0.04309	1.26250	-0.44085	-0.05239
0.77000	0.21781	0.02588	0.93500	0.77476	0.09207	1.10000	-0.37267	-0.04429	1.26500	-0.39183	-0.04656
0.77250	0.28733	0.03415	0.93750	0.83563	0.09930	1.10250	-0.31502	-0.03744	1.26750	-0.32638	-0.03879
0.77500	0.30932	0.03676	0.94000	0.82672	0.09824	1.10500	-0.19418	-0.02308	1.27000	-0.23161	-0.02752
0.77750	0.27000	0.03209	0.94250	0.75195	0.08936	1.10750	-0.04633	-0.00551	1.27250	-0.11961	-0.01421
0.78000	0.18328	0.02178	0.94500	0.62939	0.07479	1.11000	0.09639	0.01146	1.27500	-0.00469	-0.00056
0.78250	0.07988	0.00949	0.94750	0.48210	0.05729	1.11250	0.21245	0.02525	1.27750	0.10251	0.01218
0.78500	-0.00806	-0.00096	0.95000	0.33310	0.03958	1.11500	0.29787	0.03540	1.28000	0.19881	0.02363
0.78750	-0.07037	-0.00836	0.95250	0.20133	0.02393	1.11750	0.35318	0.04197	1.28250	0.28629	0.03402
0.79000	-0.11183	-0.01329	0.95500	0.10563	0.01255	1.12000	0.38199	0.04539	1.28500	0.36764	0.04369
0.79250	-0.14937	-0.01775	0.95750	0.04365	0.00519	1.12250	0.38283	0.04549	1.28750	0.42046	0.04997
0.79500	-0.18721	-0.02225	0.96000	0.00237	0.00028	1.12500	0.36389	0.04324	1.29000	0.43563	0.05177
0.79750	-0.22173	-0.02635	0.96250	-0.02385	-0.00283	1.12750	0.33646	0.03998	1.29250	0.42901	0.05098
0.80000	-0.24391	-0.02899	0.96500	-0.01972	-0.00234	1.13000	0.31098	0.03696	1.29500	0.41407	0.04921
0.80250	-0.25339	-0.03011	0.96750	0.01890	0.00225	1.13250	0.29530	0.03509	1.29750	0.38088	0.04526

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1.30000	0.32325	0.03841
1.30250	0.24093	0.02863
1.30500	0.14027	0.01667
1.30750	0.02770	0.00329
1.31000	-0.08379	-0.00996
1.31250	-0.19520	-0.02320
1.31500	-0.31048	-0.03690
1.31750	-0.42125	-0.05006
1.32000	-0.50458	-0.05996
1.32250	-0.54987	-0.06534
1.32500	-0.54777	-0.06509
1.32750	-0.49319	-0.05861
1.33000	-0.39194	-0.04658
1.33250	-0.26238	-0.03118
1.33500	-0.11550	-0.01373
1.33750	0.02140	0.00254
1.34000	0.11344	0.01348
1.34250	0.14585	0.01733
1.34500	0.13843	0.01645
1.34750	0.11438	0.01359
1.35000	0.08903	0.01058
1.35250	0.07026	0.00835
1.35500	0.07470	0.00888
1.35750	0.11348	0.01349
1.36000	0.18845	0.02240
1.36250	0.28330	0.03367
1.36500	0.37654	0.04475
1.36750	0.43688	0.05192
1.37000	0.44288	0.05263
1.37250	0.38933	0.04627
1.37500	0.29027	0.03449
1.37750	0.16313	0.01939
1.38000	0.03203	0.00381
1.38250	-0.08422	-0.01001
1.38500	-0.17310	-0.02057
1.38750	-0.23148	-0.02751
1.39000	-0.25101	-0.02983
1.39250	-0.22961	-0.02729
1.39500	-0.17241	-0.02049
1.39750	-0.09888	-0.01175
1.40000	-0.02072	-0.00246
1.40250	0.05737	0.00682
1.40500	0.13483	0.01602
1.40750	0.19376	0.02303
1.41000	0.21304	0.02532
1.41250	0.18526	0.02202
1.41500	0.12406	0.01474
1.41750	0.04223	0.00502
1.42000	-0.05115	-0.00608
1.42250	-0.15756	-0.01872
1.42500	-0.27022	-0.03211
1.42750	-0.37172	-0.04417
1.43000	-0.42931	-0.05102
1.43250	-0.42232	-0.05019
1.43500	-0.35283	-0.04193
1.43750	-0.24357	-0.02895
1.44000	-0.11301	-0.01343
1.44250	0.02688	0.00319
1.44500	0.17297	0.02056
1.44750	0.31734	0.03771
1.45000	0.44870	0.05332
1.45250	0.54182	0.06439
1.45500	0.58210	0.06917
1.45750	0.57729	0.06860
1.46000	0.55162	0.06555
1.46250	0.51153	0.06079
1.46500	0.44666	0.05308
1.46750	0.34092	0.04051
1.47000	0.19777	0.02350
1.47250	0.04068	0.00483
1.47500	-0.09466	-0.01125
1.47750	-0.19823	-0.02356
1.48000	-0.28223	-0.03354
1.48250	-0.35921	-0.04269
1.48500	-0.41692	-0.04955
1.48750	-0.43692	-0.05192
1.49000	-0.41241	-0.04901
1.49250	-0.36556	-0.04344
1.49500	-0.32501	-0.03862
1.49750	-0.30987	-0.03682
1.50000	-0.31419	-0.03734
1.50250	-0.32629	-0.03878
1.50500	-0.33641	-0.03998
1.50750	-0.34583	-0.04110
1.51000	-0.35486	-0.04217
1.51250	-0.36261	-0.04309
1.51500	-0.35749	-0.04248
1.51750	-0.33714	-0.04006
1.52000	-0.30732	-0.03652
1.52250	-0.28086	-0.03338
1.52500	-0.26285	-0.03124
1.52750	-0.25108	-0.02984
1.53000	-0.23578	-0.02802
1.53250	-0.21606	-0.02568
1.53500	-0.19272	-0.02290
1.53750	-0.17220	-0.02046
1.54000	-0.15110	-0.01796
1.54250	-0.12500	-0.01486
1.54500	-0.09458	-0.01124
1.54750	-0.07308	-0.00868
1.55000	-0.06609	-0.00785
1.55250	-0.06456	-0.00767
1.55500	-0.04607	-0.00548
1.55750	-0.00176	-0.00021
1.56000	0.07062	0.00839
1.56250	0.16508	0.01962
1.56500	0.27960	0.03323
1.56750	0.40202	0.04777
1.57000	0.50992	0.06060
1.57250	0.58050	0.06898
1.57500	0.60861	0.07233
1.57750	0.59524	0.07074
1.58000	0.54703	0.06501
1.58250	0.46435	0.05518
1.58500	0.35811	0.04256
1.58750	0.25227	0.02998
1.59000	0.18260	0.02170
1.59250	0.17014	0.02022
1.59500	0.20784	0.02470
1.59750	0.26814	0.03187
1.60000	0.34314	0.04078
1.60250	0.43358	0.05153
1.60500	0.53250	0.06328
1.60750	0.61722	0.07335
1.61000	0.66894	0.07949
1.61250	0.67546	0.08027
1.61500	0.65037	0.07729
1.61750	0.62138	0.07384
1.62000	0.60474	0.07186
1.62250	0.58713	0.06977
1.62500	0.56136	0.06671
1.62750	0.53046	0.06304
1.63000	0.49978	0.05939
1.63250	0.47324	0.05624
1.63500	0.46121	0.05481
1.63750	0.45284	0.05381
1.64000	0.42789	0.05085
1.64250	0.37305	0.04433
1.64500	0.29548	0.03511
1.64750	0.20307	0.02413
1.65000	0.10757	0.01278
1.65250	0.01813	0.00216
1.65500	-0.06013	-0.00715
1.65750	-0.12320	-0.01464
1.66000	-0.14648	-0.01741
1.66250	-0.10870	-0.01292
1.66500	-0.01745	-0.00207
1.66750	0.08722	0.01037
1.67000	0.17351	0.02062
1.67250	0.22768	0.02706
1.67500	0.25299	0.03006
1.67750	0.24570	0.02920
1.68000	0.20084	0.02387
1.68250	0.11618	0.01381
1.68500	0.00969	0.00115
1.68750	-0.09309	-0.01106
1.69000	-0.17294	-0.02055
1.69250	-0.22184	-0.02636
1.69500	-0.22726	-0.02701
1.69750	-0.18330	-0.02178
1.70000	-0.08953	-0.01064
1.70250	0.03704	0.00440
1.70500	0.17204	0.02044
1.70750	0.28523	0.03390
1.71000	0.35932	0.04270
1.71250	0.38529	0.04579
1.71500	0.36271	0.04310
1.71750	0.29013	0.03448
1.72000	0.17163	0.02040
1.72250	0.01325	0.00158
1.72500	-0.16383	-0.01947
1.72750	-0.33224	-0.03948
1.73000	-0.46693	-0.05549
1.73250	-0.56914	-0.06763
1.73500	-0.64954	-0.07719
1.73750	-0.70921	-0.08428
1.74000	-0.72565	-0.08623
1.74250	-0.68788	-0.08175
1.74500	-0.60519	-0.07192
1.74750	-0.50086	-0.05952
1.75000	-0.39093	-0.04646
1.75250	-0.28437	-0.03379
1.75500	-0.18420	-0.02189
1.75750	-0.10644	-0.01265
1.76000	-0.06812	-0.00810
1.76250	-0.08480	-0.01008
1.76500	-0.15521	-0.01844
1.76750	-0.26459	-0.03144
1.77000	-0.38416	-0.04565
1.77250	-0.49093	-0.05834
1.77500	-0.57485	-0.06831
1.77750	-0.63734	-0.07574
1.78000	-0.67104	-0.07974
1.78250	-0.66923	-0.07953
1.78500	-0.62820	-0.07465
1.78750	-0.55952	-0.06649
1.79000	-0.47654	-0.05663
1.79250	-0.39657	-0.04713
1.79500	-0.32801	-0.03898
1.79750	-0.28029	-0.03331
1.80000	-0.25991	-0.03089
1.80250	-0.26419	-0.03140
1.80500	-0.27590	-0.03279
1.80750	-0.28672	-0.03407
1.81000	-0.29516	-0.03508
1.81250	-0.30626	-0.03640
1.81500	-0.31539	-0.03748
1.81750	-0.31246	-0.03713
1.82000	-0.28867	-0.03430
1.82250	-0.25691	-0.03053
1.82500	-0.22742	-0.02703
1.82750	-0.20589	-0.02447
1.83000	-0.19454	-0.02312
1.83250	-0.19211	-0.02283
1.83500	-0.18814	-0.02236
1.83750	-0.17770	-0.02112
1.84000	-0.15646	-0.01859
1.84250	-0.13031	-0.01549
1.84500	-0.10387	-0.01234
1.84750	-0.07643	-0.00908
1.85000	-0.03150	-0.00374
1.85250	0.03967	0.00471
1.85500	0.13176	0.01566
1.85750	0.22930	0.02725
1.86000	0.32349	0.03844
1.86250	0.40623	0.04828
1.86500	0.47886	0.05691
1.86750	0.54211	0.06442
1.87000	0.59741	0.07099
1.87250	0.63360	0.07529
1.87500	0.64201	0.07629
1.87750	0.62449	0.07421
1.88000	0.59615	0.07084
1.88250	0.56683	0.06736
1.88500	0.54029	0.06421
1.88750	0.50574	0.06010
1.89000	0.45364	0.05391
1.89250	0.37796	0.04492
1.89500	0.28463	0.03382
1.89750	0.17673	0.02100
1.90000	0.06104	0.00725
1.90250	-0.05346	-0.00635
1.90500	-0.15041	-0.01787
1.90750	-0.21829	-0.02594
1.91000	-0.24934	-0.02963
1.91250	-0.24191	-0.02875
1.91500	-0.18896	-0.02246
1.91750	-0.09234	-0.01097
1.92000	0.04189	0.00498
1.92250	0.19890	0.02364
1.92500	0.36036	0.04282
1.92750	0.50086	0.05952
1.93000	0.60807	0.07226
1.93250	0.67522	0.08024
1.93500	0.69958	0.08314
1.93750	0.67648	0.08039
1.94000	0.61120	0.07263
1.94250	0.51633	0.06136
1.94500	0.40855	0.04855
1.94750	0.29273	0.03479
1.95000	0.17619	0.02094
1.95250	0.06309	0.00750
1.95500	-0.03820	-0.00454
1.95750	-0.12413	-0.01475

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1.96000	-0.19372	-0.02302
1.96250	-0.25069	-0.02979
1.96500	-0.29194	-0.03469
1.96750	-0.31610	-0.03756
1.97000	-0.32075	-0.03812
1.97250	-0.31438	-0.03736
1.97500	-0.30730	-0.03652
1.97750	-0.31019	-0.03686
1.98000	-0.31776	-0.03776
1.98250	-0.31934	-0.03795
1.98500	-0.30351	-0.03607
1.98750	-0.26865	-0.03193
1.99000	-0.21756	-0.02585
1.99250	-0.16091	-0.01912
1.99500	-0.10593	-0.01259
1.99750	-0.06267	-0.00745
2.00000	-0.03017	-0.00359
2.00250	-0.01118	-0.00133
2.00500	-0.01097	-0.00130
2.00750	-0.03675	-0.00437
2.01000	-0.08585	-0.01020
2.01250	-0.14577	-0.01732
2.01500	-0.19885	-0.02363
2.01750	-0.24232	-0.02880
2.02000	-0.27923	-0.03318
2.02250	-0.32188	-0.03825
2.02500	-0.37393	-0.04444
2.02750	-0.43135	-0.05126
2.03000	-0.48331	-0.05743
2.03250	-0.53043	-0.06303
2.03500	-0.57261	-0.06805
2.03750	-0.60319	-0.07168
2.04000	-0.60774	-0.07222
2.04250	-0.58496	-0.06951
2.04500	-0.54214	-0.06443
2.04750	-0.49178	-0.05844
2.05000	-0.43559	-0.05176
2.05250	-0.37438	-0.04449
2.05500	-0.30380	-0.03610
2.05750	-0.22355	-0.02657
2.06000	-0.13526	-0.01607
2.06250	-0.04983	-0.00592
2.06500	0.02474	0.00294
2.06750	0.08383	0.00996
2.07000	0.13312	0.01582
2.07250	0.17353	0.02062
2.07500	0.20704	0.02460
2.07750	0.23237	0.02761
2.08000	0.25409	0.03020
2.08250	0.27223	0.03235
2.08500	0.28364	0.03371
2.08750	0.28001	0.03328
2.09000	0.26286	0.03124
2.09250	0.23671	0.02813
2.09500	0.20589	0.02447
2.09750	0.16475	0.01958
2.10000	0.11218	0.01333
2.10250	0.05162	0.00613
2.10500	0.00017	0.00002
2.10750	-0.02896	-0.00344
2.11000	-0.02862	-0.00340
2.11250	-0.00261	-0.00031
2.11500	0.04562	0.00542
2.11750	0.10835	0.01288
2.12000	0.17884	0.02125
2.12250	0.24262	0.02883
2.12500	0.29094	0.03457
2.12750	0.31790	0.03778
2.13000	0.32123	0.03817
2.13250	0.29670	0.03526
2.13500	0.25380	0.03016
2.13750	0.20505	0.02437
2.14000	0.16348	0.01943
2.14250	0.13415	0.01594
2.14500	0.12263	0.01457
2.14750	0.12805	0.01522
2.15000	0.15581	0.01852
2.15250	0.20882	0.02482
2.15500	0.27921	0.03318
2.15750	0.34269	0.04072
2.16000	0.38112	0.04529
2.16250	0.38359	0.04558
2.16500	0.35338	0.04199
2.16750	0.29462	0.03501
2.17000	0.21311	0.02533
2.17250	0.10898	0.01295
2.17500	-0.00990	-0.00118
2.17750	-0.12971	-0.01541
2.18000	-0.22471	-0.02670
2.18250	-0.27544	-0.03273
2.18500	-0.27282	-0.03242
2.18750	-0.22465	-0.02670
2.19000	-0.13903	-0.01652
2.19250	-0.02758	-0.00328
2.19500	0.10005	0.01189
2.19750	0.23339	0.02774
2.20000	0.36215	0.04304
2.20250	0.46144	0.05484
2.20500	0.51156	0.06079
2.20750	0.50361	0.05985
2.21000	0.44941	0.05341
2.21250	0.36901	0.04385
2.21500	0.28594	0.03398
2.21750	0.21078	0.02505
2.22000	0.14842	0.01764
2.22250	0.10106	0.01201
2.22500	0.07530	0.00895
2.22750	0.06679	0.00794
2.23000	0.06814	0.00810
2.23250	0.06843	0.00813
2.23500	0.06172	0.00734
2.23750	0.03841	0.00456
2.24000	-0.00411	-0.00049
2.24250	-0.06480	-0.00770
2.24500	-0.12860	-0.01528
2.24750	-0.18088	-0.02150
2.25000	-0.21818	-0.02593
2.25250	-0.25216	-0.02997
2.25500	-0.28269	-0.03359
2.25750	-0.29801	-0.03541
2.26000	-0.28194	-0.03351
2.26250	-0.23474	-0.02790
2.26500	-0.16807	-0.01997
2.26750	-0.10398	-0.01236
2.27000	-0.05165	-0.00614
2.27250	-0.00860	-0.00102
2.27500	0.03446	0.00410
2.27750	0.07335	0.00872
2.28000	0.09826	0.01168
2.28250	0.09889	0.01175
2.28500	0.08212	0.00976
2.28750	0.06008	0.00714
2.29000	0.04365	0.00519
2.29250	0.03142	0.00373
2.29500	0.02146	0.00255
2.29750	0.00745	0.00089
2.30000	-0.01417	-0.00168
2.30250	-0.05095	-0.00606
2.30500	-0.10507	-0.01249
2.30750	-0.17905	-0.02128
2.31000	-0.26989	-0.03207
2.31250	-0.37505	-0.04457
2.31500	-0.48335	-0.05744
2.31750	-0.58449	-0.06946
2.32000	-0.66356	-0.07886
2.32250	-0.71110	-0.08450
2.32500	-0.72054	-0.08563
2.32750	-0.69606	-0.08272
2.33000	-0.63947	-0.07599
2.33250	-0.55478	-0.06593
2.33500	-0.44670	-0.05308
2.33750	-0.32549	-0.03868
2.34000	-0.19580	-0.02327
2.34250	-0.06616	-0.00786
2.34500	0.05762	0.00685
2.34750	0.16416	0.01951
2.35000	0.24246	0.02881
2.35250	0.28055	0.03334
2.35500	0.27669	0.03288
2.35750	0.23296	0.02768
2.36000	0.16020	0.01904
2.36250	0.06894	0.00819
2.36500	-0.02254	-0.00268
2.36750	-0.09968	-0.01185
2.37000	-0.15131	-0.01798
2.37250	-0.17790	-0.02114
2.37500	-0.18015	-0.02141
2.37750	-0.16334	-0.01941
2.38000	-0.13190	-0.01567
2.38250	-0.09640	-0.01146
2.38500	-0.06312	-0.00750
2.38750	-0.03933	-0.00467
2.39000	-0.02387	-0.00284
2.39250	-0.01530	-0.00182
2.39500	-0.01034	-0.00123
2.39750	-0.01087	-0.00129
2.40000	-0.01184	-0.00141
2.40250	-0.00455	-0.00054
2.40500	0.02306	0.00274
2.40750	0.06726	0.00799
2.41000	0.12290	0.01461
2.41250	0.19090	0.02269
2.41500	0.27826	0.03307
2.41750	0.37634	0.04472
2.42000	0.47085	0.05595
2.42250	0.54692	0.06499
2.42500	0.59788	0.07105
2.42750	0.62012	0.07369
2.43000	0.62286	0.07402
2.43250	0.60919	0.07239
2.43500	0.57713	0.06858
2.43750	0.52370	0.06223
2.44000	0.45778	0.05440
2.44250	0.38695	0.04598
2.44500	0.31896	0.03790
2.44750	0.25511	0.03032
2.45000	0.19753	0.02347
2.45250	0.14300	0.01699
2.45500	0.09453	0.01123
2.45750	0.05616	0.00667
2.46000	0.03667	0.00436
2.46250	0.03613	0.00429
2.46500	0.05158	0.00613
2.46750	0.07568	0.00899
2.47000	0.10640	0.01264
2.47250	0.13861	0.01647
2.47500	0.17147	0.02038
2.47750	0.20288	0.02411
2.48000	0.23069	0.02741
2.48250	0.24231	0.02880
2.48500	0.23019	0.02736
2.48750	0.19074	0.02267
2.49000	0.13008	0.01546
2.49250	0.05553	0.00660
2.49500	-0.01993	-0.00237
2.49750	-0.09154	-0.01088
2.50000	-0.15770	-0.01874
2.50250	-0.21989	-0.02613
2.50500	-0.27257	-0.03239
2.50750	-0.31599	-0.03755
2.51000	-0.35324	-0.04198
2.51250	-0.39145	-0.04652
2.51500	-0.43026	-0.05113
2.51750	-0.47174	-0.05606
2.52000	-0.51130	-0.06076
2.52250	-0.54285	-0.06451
2.52500	-0.55700	-0.06619
2.52750	-0.55404	-0.06584
2.53000	-0.53630	-0.06373
2.53250	-0.50943	-0.06054
2.53500	-0.47380	-0.05630
2.53750	-0.43334	-0.05150
2.54000	-0.38981	-0.04632
2.54250	-0.34840	-0.04140
2.54500	-0.31041	-0.03689
2.54750	-0.28211	-0.03353
2.55000	-0.26479	-0.03147
2.55250	-0.26164	-0.03109
2.55500	-0.27223	-0.03235
2.55750	-0.29633	-0.03521
2.56000	-0.32447	-0.03856
2.56250	-0.34886	-0.04146
2.56500	-0.36342	-0.04319
2.56750	-0.36971	-0.04394
2.57000	-0.36552	-0.04344
2.57250	-0.35195	-0.04182
2.57500	-0.32632	-0.03878
2.57750	-0.29124	-0.03461
2.58000	-0.24849	-0.02953
2.58250	-0.20257	-0.02407
2.58500	-0.15351	-0.01824
2.58750	-0.10318	-0.01226
2.59000	-0.04552	-0.00541
2.59250	0.02337	0.00278
2.59500	0.10416	0.01238
2.59750	0.18522	0.02201
2.60000	0.25641	0.03047
2.60250	0.31018	0.03686
2.60500	0.35054	0.04166
2.60750	0.37831	0.04496
2.61000	0.39000	0.04635
2.61250	0.37767	0.04488
2.61500	0.34703	0.04124
2.61750	0.30800	0.03660

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2.62000	0.27209	0.03233
2.62250	0.24213	0.02877
2.62500	0.22155	0.02633
2.62750	0.20930	0.02487
2.63000	0.20792	0.02471
2.63250	0.21447	0.02549
2.63500	0.22724	0.02700
2.63750	0.24037	0.02857
2.64000	0.25290	0.03005
2.64250	0.26314	0.03127
2.64500	0.27332	0.03248
2.64750	0.28124	0.03342
2.65000	0.28749	0.03416
2.65250	0.28984	0.03444
2.65500	0.29102	0.03458
2.65750	0.29242	0.03475
2.66000	0.30030	0.03569
2.66250	0.31404	0.03732
2.66500	0.33156	0.03940
2.66750	0.34825	0.04139
2.67000	0.36891	0.04384
2.67250	0.39425	0.04685
2.67500	0.42073	0.05000
2.67750	0.43547	0.05175
2.68000	0.42963	0.05106
2.68250	0.39454	0.04689
2.68500	0.33291	0.03956
2.68750	0.25246	0.03000
2.69000	0.16605	0.01973
2.69250	0.07947	0.00944
2.69500	0.00066	0.00008
2.69750	-0.06373	-0.00757
2.70000	-0.10353	-0.01230
2.70250	-0.11699	-0.01390
2.70500	-0.10475	-0.01245
2.70750	-0.07522	-0.00894
2.71000	-0.03528	-0.00419
2.71250	0.00335	0.00040
2.71500	0.03234	0.00384
2.71750	0.04316	0.00513
2.72000	0.03731	0.00443
2.72250	0.01732	0.00206
2.72500	-0.01098	-0.00131
2.72750	-0.04440	-0.00528
2.73000	-0.07382	-0.00877
2.73250	-0.09356	-0.01112
2.73500	-0.09541	-0.01134
2.73750	-0.07726	-0.00918
2.74000	-0.04154	-0.00494
2.74250	-0.00046	-0.00006
2.74500	0.04118	0.00489
2.74750	0.07571	0.00900
2.75000	0.09517	0.01131
2.75250	0.09075	0.01078
2.75500	0.06405	0.00761
2.75750	0.01937	0.00230
2.76000	-0.03333	-0.00396
2.76250	-0.08966	-0.01066
2.76500	-0.14410	-0.01712
2.76750	-0.19486	-0.02316
2.77000	-0.23342	-0.02774
2.77250	-0.25472	-0.03027
2.77500	-0.25743	-0.03059
2.77750	-0.25045	-0.02976
2.78000	-0.23871	-0.02837
2.78250	-0.22526	-0.02677
2.78500	-0.20667	-0.02456
2.78750	-0.18377	-0.02184
2.79000	-0.15670	-0.01862
2.79250	-0.13216	-0.01571
2.79500	-0.11029	-0.01311
2.79750	-0.09109	-0.01083
2.80000	-0.07056	-0.00839
2.80250	-0.04903	-0.00583
2.80500	-0.02668	-0.00317
2.80750	-0.00919	-0.00109
2.81000	0.00141	0.00017
2.81250	0.00186	0.00022
2.81500	-0.00421	-0.00050
2.81750	-0.01373	-0.00163
2.82000	-0.02126	-0.00253
2.82250	-0.03031	-0.00360
2.82500	-0.04254	-0.00506
2.82750	-0.05890	-0.00700
2.83000	-0.07203	-0.00856
2.83250	-0.07887	-0.00937
2.83500	-0.07917	-0.00941
2.83750	-0.07940	-0.00944
2.84000	-0.07923	-0.00942
2.84250	-0.07785	-0.00925
2.84500	-0.07262	-0.00863
2.84750	-0.06846	-0.00814
2.85000	-0.06541	-0.00777
2.85250	-0.06468	-0.00769
2.85500	-0.06453	-0.00767
2.85750	-0.06569	-0.00781
2.86000	-0.06345	-0.00754
2.86250	-0.05755	-0.00684
2.86500	-0.04578	-0.00544
2.86750	-0.03056	-0.00363
2.87000	-0.01159	-0.00138
2.87250	0.00894	0.00106
2.87500	0.03235	0.00384
2.87750	0.05440	0.00647
2.88000	0.07461	0.00887
2.88250	0.09326	0.01108
2.88500	0.11434	0.01359
2.88750	0.13049	0.01551
2.89000	0.13610	0.01617
2.89250	0.12894	0.01532
2.89500	0.11314	0.01345
2.89750	0.08782	0.01044
2.90000	0.05423	0.00645
2.90250	0.00900	0.00107
2.90500	-0.04293	-0.00510
2.90750	-0.09219	-0.01096
2.91000	-0.12586	-0.01496
2.91250	-0.14189	-0.01686
2.91500	-0.14075	-0.01673
2.91750	-0.12533	-0.01489
2.92000	-0.09257	-0.01100
2.92250	-0.04680	-0.00556
2.92500	0.00581	0.00069
2.92750	0.05361	0.00637
2.93000	0.08965	0.01065
2.93250	0.10775	0.01280
2.93500	0.10918	0.01297
2.93750	0.09377	0.01114
2.94000	0.06631	0.00788
2.94250	0.02952	0.00351
2.94500	-0.00989	-0.00118
2.94750	-0.05022	-0.00597
2.95000	-0.08774	-0.01043
2.95250	-0.12021	-0.01429
2.95500	-0.13855	-0.01647
2.95750	-0.14133	-0.01680
2.96000	-0.13079	-0.01554
2.96250	-0.11286	-0.01341
2.96500	-0.08673	-0.01031
2.96750	-0.05593	-0.00665
2.97000	-0.02369	-0.00282
2.97250	0.00136	0.00016
2.97500	0.01523	0.00181
2.97750	0.01473	0.00175
2.98000	0.00322	0.00038
2.98250	-0.01970	-0.00234
2.98500	-0.05079	-0.00604
2.98750	-0.08662	-0.01029
2.99000	-0.11696	-0.01390
2.99250	-0.13661	-0.01623
2.99500	-0.14033	-0.01668
2.99750	-0.12821	-0.01524
3.00000	-0.09630	-0.01144
3.00250	-0.04664	-0.00554
3.00500	0.01572	0.00187
3.00750	0.07898	0.00939
3.01000	0.13532	0.01608
3.01250	0.17421	0.02070
3.01500	0.19111	0.02271
3.01750	0.18185	0.02161
3.02000	0.14908	0.01772
3.02250	0.09709	0.01154
3.02500	0.03772	0.00448
3.02750	-0.02365	-0.00281
3.03000	-0.08428	-0.01002
3.03250	-0.14547	-0.01729
3.03500	-0.19930	-0.02368
3.03750	-0.23967	-0.02848
3.04000	-0.26211	-0.03115
3.04250	-0.27248	-0.03238
3.04500	-0.27565	-0.03276
3.04750	-0.27387	-0.03255
3.05000	-0.26012	-0.03091
3.05250	-0.23463	-0.02788
3.05500	-0.19924	-0.02368
3.05750	-0.16112	-0.01915
3.06000	-0.12375	-0.01471
3.06250	-0.09331	-0.01109
3.06500	-0.07005	-0.00832
3.06750	-0.05507	-0.00654
3.07000	-0.04533	-0.00539
3.07250	-0.03971	-0.00472
3.07500	-0.03427	-0.00407
3.07750	-0.03079	-0.00366
3.08000	-0.02544	-0.00302
3.08250	-0.01629	-0.00194
3.08500	-0.00119	-0.00014
3.08750	0.01348	0.00160
3.09000	0.02479	0.00295
3.09250	0.03156	0.00375
3.09500	0.03824	0.00454
3.09750	0.04223	0.00502
3.10000	0.04206	0.00500
3.10250	0.03636	0.00432
3.10500	0.03245	0.00386
3.10750	0.03184	0.00378
3.11000	0.03422	0.00407
3.11250	0.03495	0.00415
3.11500	0.03703	0.00440
3.11750	0.04359	0.00518
3.12000	0.05944	0.00706
3.12250	0.08109	0.00964
3.12500	0.10636	0.01264
3.12750	0.13173	0.01565
3.13000	0.15902	0.01890
3.13250	0.18587	0.02209
3.13500	0.21117	0.02510
3.13750	0.22972	0.02730
3.14000	0.24370	0.02896
3.14250	0.25472	0.03027
3.14500	0.26634	0.03165
3.14750	0.27573	0.03277
3.15000	0.28234	0.03355
3.15250	0.28279	0.03361
3.15500	0.27958	0.03322
3.15750	0.27284	0.03242
3.16000	0.26471	0.03146
3.16250	0.25251	0.03001
3.16500	0.23756	0.02823
3.16750	0.21972	0.02611
3.17000	0.20301	0.02413
3.17250	0.18688	0.02221
3.17500	0.17461	0.02075
3.17750	0.16626	0.01976
3.18000	0.16410	0.01950
3.18250	0.16428	0.01952
3.18500	0.16557	0.01968
3.18750	0.16615	0.01975
3.19000	0.16944	0.02014
3.19250	0.17383	0.02066
3.19500	0.17941	0.02132
3.19750	0.18059	0.02146
3.20000	0.17514	0.02081
3.20250	0.16094	0.01913
3.20500	0.14178	0.01685
3.20750	0.11675	0.01387
3.21000	0.08780	0.01043
3.21250	0.05492	0.00653
3.21500	0.02334	0.00277
3.21750	-0.00501	-0.00060
3.22000	-0.02515	-0.00299
3.22250	-0.03666	-0.00436
3.22500	-0.03857	-0.00458
3.22750	-0.03653	-0.00434
3.23000	-0.03272	-0.00389
3.23250	-0.03153	-0.00375
3.23500	-0.03341	-0.00397
3.23750	-0.04172	-0.00496
3.24000	-0.05321	-0.00632
3.24250	-0.06646	-0.00790
3.24500	-0.07993	-0.00950
3.24750	-0.09650	-0.01147
3.25000	-0.11249	-0.01337
3.25250	-0.12845	-0.01527
3.25500	-0.14427	-0.01714
3.25750	-0.16402	-0.01949
3.26000	-0.18793	-0.02233
3.26250	-0.21930	-0.02606
3.26500	-0.25441	-0.03023
3.26750	-0.28692	-0.03410
3.27000	-0.30599	-0.03636
3.27250	-0.31012	-0.03685
3.27500	-0.29942	-0.03558
3.27750	-0.27875	-0.03313

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3.28000	-0.24885	-0.02957
3.28250	-0.21345	-0.02537
3.28500	-0.17510	-0.02081
3.28750	-0.14422	-0.01714
3.29000	-0.12916	-0.01535
3.29250	-0.13702	-0.01628
3.29500	-0.16146	-0.01919
3.29750	-0.19494	-0.02317
3.30000	-0.22898	-0.02721
3.30250	-0.26073	-0.03098
3.30500	-0.28293	-0.03362
3.30750	-0.29035	-0.03450
3.31000	-0.27599	-0.03280
3.31250	-0.24273	-0.02885
3.31500	-0.19605	-0.02330
3.31750	-0.14582	-0.01733
3.32000	-0.09478	-0.01126
3.32250	-0.04648	-0.00552
3.32500	-0.00353	-0.00042
3.32750	0.02781	0.00331
3.33000	0.04854	0.00577
3.33250	0.05826	0.00692
3.33500	0.06050	0.00719
3.33750	0.05477	0.00651
3.34000	0.04432	0.00527
3.34250	0.02943	0.00350
3.34500	0.01392	0.00165
3.34750	-0.00126	-0.00015
3.35000	-0.01149	-0.00137
3.35250	-0.01526	-0.00181
3.35500	-0.00854	-0.00102
3.35750	0.00553	0.00066
3.36000	0.02434	0.00289
3.36250	0.04268	0.00507
3.36500	0.06282	0.00747
3.36750	0.08438	0.01003
3.37000	0.10796	0.01283
3.37250	0.12943	0.01538
3.37500	0.14862	0.01766
3.37750	0.16323	0.01940
3.38000	0.17543	0.02085
3.38250	0.18309	0.02176
3.38500	0.18701	0.02222
3.38750	0.18407	0.02187
3.39000	0.17459	0.02075
3.39250	0.15656	0.01861
3.39500	0.13336	0.01585
3.39750	0.10788	0.01282
3.40000	0.08831	0.01049
3.40250	0.07733	0.00919
3.40500	0.07581	0.00901
3.40750	0.07685	0.00913
3.41000	0.07966	0.00947
3.41250	0.08322	0.00989
3.41500	0.08712	0.01035
3.41750	0.08384	0.00996
3.42000	0.07132	0.00848
3.42250	0.04938	0.00587
3.42500	0.02440	0.00290
3.42750	-0.00146	-0.00017
3.43000	-0.02373	-0.00282
3.43250	-0.04154	-0.00494
3.43500	-0.05019	-0.00596
3.43750	-0.04928	-0.00586
3.44000	-0.03801	-0.00452
3.44250	-0.02296	-0.00273
3.44500	-0.00746	-0.00089
3.44750	0.00420	0.00050
3.45000	0.01371	0.00163
3.45250	0.02098	0.00249
3.45500	0.02875	0.00342
3.45750	0.03473	0.00413
3.46000	0.04112	0.00489
3.46250	0.04912	0.00584
3.46500	0.06256	0.00743
3.46750	0.07682	0.00913
3.47000	0.08833	0.01050
3.47250	0.09218	0.01095
3.47500	0.08938	0.01062
3.47750	0.07753	0.00921
3.48000	0.05664	0.00673
3.48250	0.02351	0.00279
3.48500	-0.01797	-0.00214
3.48750	-0.06385	-0.00759
3.49000	-0.10706	-0.01272
3.49250	-0.14606	-0.01736
3.49500	-0.17587	-0.02090
3.49750	-0.19390	-0.02304
3.50000	-0.19556	-0.02324
3.50250	-0.18436	-0.02191
3.50500	-0.16374	-0.01946
3.50750	-0.14175	-0.01685
3.51000	-0.12072	-0.01435
3.51250	-0.10361	-0.01231
3.51500	-0.08994	-0.01069
3.51750	-0.08229	-0.00978
3.52000	-0.07746	-0.00921
3.52250	-0.07405	-0.00880
3.52500	-0.06753	-0.00803
3.52750	-0.05804	-0.00690
3.53000	-0.04306	-0.00512
3.53250	-0.02565	-0.00305
3.53500	-0.00767	-0.00091
3.53750	0.00601	0.00071
3.54000	0.01549	0.00184
3.54250	0.01781	0.00212
3.54500	0.01564	0.00186
3.54750	0.01062	0.00126
3.55000	0.00711	0.00085
3.55250	0.00327	0.00039
3.55500	-0.00030	-0.00004
3.55750	-0.00494	-0.00059
3.56000	-0.00679	-0.00081
3.56250	-0.00672	-0.00080
3.56500	-0.00385	-0.00046
3.56750	-0.00140	-0.00017
3.57000	0.00184	0.00022
3.57250	0.00555	0.00066
3.57500	0.01314	0.00156
3.57750	0.02248	0.00267
3.58000	0.03341	0.00397
3.58250	0.04305	0.00512
3.58500	0.05340	0.00635
3.58750	0.06228	0.00740
3.59000	0.06931	0.00824
3.59250	0.07098	0.00844
3.59500	0.06959	0.00827
3.59750	0.06521	0.00775
3.60000	0.06129	0.00728
3.60250	0.05768	0.00685
3.60500	0.05795	0.00689
3.60750	0.06082	0.00723
3.61000	0.06689	0.00795
3.61250	0.07378	0.00877
3.61500	0.08375	0.00995
3.61750	0.09520	0.01131
3.62000	0.10668	0.01268
3.62250	0.11009	0.01308
3.62500	0.10280	0.01222
3.62750	0.08438	0.01003
3.63000	0.06209	0.00738
3.63250	0.03940	0.00468
3.63500	0.01947	0.00231
3.63750	-0.00040	-0.00005
3.64000	-0.01752	-0.00208
3.64250	-0.02960	-0.00352
3.64500	-0.03069	-0.00365
3.64750	-0.02200	-0.00261
3.65000	-0.00613	-0.00073
3.65250	0.00777	0.00092
3.65500	0.01710	0.00203
3.65750	0.02160	0.00257
3.66000	0.02631	0.00313
3.66250	0.03042	0.00362
3.66500	0.03395	0.00404
3.66750	0.03354	0.00399
3.67000	0.03102	0.00369
3.67250	0.02567	0.00305
3.67500	0.02004	0.00238
3.67750	0.01139	0.00135
3.68000	0.00044	0.00005
3.68250	-0.01348	-0.00160
3.68500	-0.02703	-0.00321
3.68750	-0.04093	-0.00486
3.69000	-0.05205	-0.00619
3.69250	-0.05999	-0.00713
3.69500	-0.06092	-0.00724
3.69750	-0.05588	-0.00664
3.70000	-0.04427	-0.00526
3.70250	-0.03086	-0.00367
3.70500	-0.01794	-0.00213
3.70750	-0.01071	-0.00127
3.71000	-0.00888	-0.00106
3.71250	-0.01366	-0.00162
3.71500	-0.02111	-0.00251
3.71750	-0.02989	-0.00355
3.72000	-0.03594	-0.00427
3.72250	-0.04039	-0.00480
3.72500	-0.04129	-0.00491
3.72750	-0.03995	-0.00475
3.73000	-0.03406	-0.00405
3.73250	-0.02510	-0.00298
3.73500	-0.01282	-0.00152
3.73750	-0.00247	-0.00029
3.74000	0.00482	0.00057
3.74250	0.00719	0.00085
3.74500	0.00776	0.00092
3.74750	0.00522	0.00062
3.75000	0.00150	0.00018
3.75250	-0.00427	-0.00051
3.75500	-0.00995	-0.00118
3.75750	-0.01686	-0.00200
3.76000	-0.02158	-0.00256
3.76250	-0.02339	-0.00278
3.76500	-0.01828	-0.00217
3.76750	-0.00728	-0.00087
3.77000	0.01017	0.00121
3.77250	0.03029	0.00360
3.77500	0.05341	0.00635
3.77750	0.07635	0.00907
3.78000	0.09900	0.01177
3.78250	0.11703	0.01391
3.78500	0.12991	0.01544
3.78750	0.13575	0.01613
3.79000	0.13666	0.01624
3.79250	0.13053	0.01551
3.79500	0.11985	0.01424
3.79750	0.10557	0.01255
3.80000	0.09249	0.01099
3.80250	0.07986	0.00949
3.80500	0.06959	0.00827
3.80750	0.06004	0.00714
3.81000	0.05125	0.00609
3.81250	0.03858	0.00459
3.81500	0.02317	0.00275
3.81750	0.00478	0.00057
3.82000	-0.01340	-0.00159
3.82250	-0.03145	-0.00374
3.82500	-0.04501	-0.00535
3.82750	-0.05379	-0.00639
3.83000	-0.05516	-0.00656
3.83250	-0.05061	-0.00601
3.83500	-0.03861	-0.00459
3.83750	-0.02273	-0.00270
3.84000	-0.00395	-0.00047
3.84250	0.01359	0.00162
3.84500	0.02900	0.00345
3.84750	0.03793	0.00451
3.85000	0.04105	0.00488
3.85250	0.03687	0.00438
3.85500	0.02848	0.00338
3.85750	0.01508	0.00179
3.86000	-0.00204	-0.00024
3.86250	-0.02384	-0.00283
3.86500	-0.04517	-0.00537
3.86750	-0.06413	-0.00762
3.87000	-0.07721	-0.00918
3.87250	-0.08657	-0.01029
3.87500	-0.09166	-0.01089
3.87750	-0.09516	-0.01131
3.88000	-0.09526	-0.01132
3.88250	-0.09390	-0.01116
3.88500	-0.09087	-0.01080
3.88750	-0.08945	-0.01063
3.89000	-0.08824	-0.01049
3.89250	-0.08935	-0.01062
3.89500	-0.09114	-0.01083
3.89750	-0.09468	-0.01125
3.90000	-0.09685	-0.01151
3.90250	-0.09764	-0.01160
3.90500	-0.09310	-0.01106
3.90750	-0.08359	-0.00993
3.91000	-0.06793	-0.00807
3.91250	-0.04890	-0.00581
3.91500	-0.02624	-0.00312
3.91750	-0.00454	-0.00054
3.92000	0.01585	0.00188
3.92250	0.03254	0.00387
3.92500	0.04617	0.00549
3.92750	0.05357	0.00637
3.93000	0.05625	0.00669
3.93250	0.05358	0.00637
3.93500	0.04911	0.00584
3.93750	0.04314	0.00513

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3.94000	0.03844	0.00457
3.94250	0.03318	0.00394
3.94500	0.02957	0.00351
3.94750	0.02682	0.00319
3.95000	0.02688	0.00319
3.95250	0.02710	0.00322
3.95500	0.02763	0.00328
3.95750	0.02516	0.00299
3.96000	0.02063	0.00245
3.96250	0.01159	0.00138
3.96500	-0.00029	-0.00004
3.96750	-0.01476	-0.00175
3.97000	-0.02716	-0.00323
3.97250	-0.03739	-0.00444
3.97500	-0.04251	-0.00505
3.97750	-0.04381	-0.00521
3.98000	-0.03973	-0.00472
3.98250	-0.03181	-0.00378
3.98500	-0.01856	-0.00221
3.98750	-0.00385	-0.00046
3.99000	0.01104	0.00131
3.99250	0.02191	0.00260
3.99500	0.02811	0.00334
3.99750	0.02535	0.00301
4.00000	0.01485	0.00177
4.00250	-0.00329	-0.00039
4.00500	-0.02468	-0.00293
4.00750	-0.04857	-0.00577
4.01000	-0.07059	-0.00839
4.01250	-0.09049	-0.01075
4.01500	-0.10547	-0.01253
4.01750	-0.11593	-0.01378
4.02000	-0.11789	-0.01401
4.02250	-0.11227	-0.01334
4.02500	-0.10010	-0.01190
4.02750	-0.08699	-0.01034
4.03000	-0.07291	-0.00866
4.03250	-0.05984	-0.00711
4.03500	-0.04616	-0.00549
4.03750	-0.03456	-0.00411
4.04000	-0.02504	-0.00298
4.04250	-0.02071	-0.00246
4.04500	-0.01908	-0.00227
4.04750	-0.02003	-0.00238
4.05000	-0.02041	-0.00243
4.05250	-0.02116	-0.00252
4.05500	-0.02024	-0.00241
4.05750	-0.01996	-0.00237
4.06000	-0.01966	-0.00234
4.06250	-0.02200	-0.00261
4.06500	-0.02473	-0.00294
4.06750	-0.02774	-0.00330
4.07000	-0.02814	-0.00334
4.07250	-0.02870	-0.00341
4.07500	-0.02843	-0.00338
4.07750	-0.02760	-0.00328
4.08000	-0.02303	-0.00274
4.08250	-0.01743	-0.00207
4.08500	-0.01096	-0.00130
4.08750	-0.00651	-0.00077
4.09000	-0.00255	-0.00030
4.09250	-0.00097	-0.00012
4.09500	0.00051	0.00006
4.09750	0.00152	0.00018
4.10000	0.00475	0.00057
4.10250	0.00941	0.00112
4.10500	0.01747	0.00208
4.10750	0.02529	0.00301
4.11000	0.03217	0.00382
4.11250	0.03510	0.00417
4.11500	0.03629	0.00431
4.11750	0.03516	0.00418
4.12000	0.03450	0.00410
4.12250	0.03329	0.00396
4.12500	0.03383	0.00402
4.12750	0.03544	0.00421
4.13000	0.04058	0.00482
4.13250	0.04669	0.00555
4.13500	0.05430	0.00645
4.13750	0.06007	0.00714
4.14000	0.06362	0.00756
4.14250	0.06177	0.00734
4.14500	0.05640	0.00670
4.14750	0.04639	0.00551
4.15000	0.03413	0.00406
4.15250	0.01869	0.00222
4.15500	0.00304	0.00036
4.15750	-0.01319	-0.00157
4.16000	-0.02592	-0.00308
4.16250	-0.03408	-0.00405
4.16500	-0.03491	-0.00415
4.16750	-0.03183	-0.00378
4.17000	-0.02559	-0.00304
4.17250	-0.01905	-0.00226
4.17500	-0.01078	-0.00128
4.17750	-0.00363	-0.00043
4.18000	0.00249	0.00030
4.18250	0.00392	0.00047
4.18500	0.00133	0.00016
4.18750	-0.00598	-0.00071
4.19000	-0.01346	-0.00160
4.19250	-0.02024	-0.00241
4.19500	-0.02330	-0.00277
4.19750	-0.02424	-0.00288
4.20000	-0.02121	-0.00252
4.20250	-0.01548	-0.00184
4.20500	-0.00507	-0.00060
4.20750	0.00755	0.00090
4.21000	0.02217	0.00263
4.21250	0.03375	0.00401
4.21500	0.04137	0.00492
4.21750	0.04290	0.00510
4.22000	0.04133	0.00491
4.22250	0.03537	0.00420
4.22500	0.02736	0.00325
4.22750	0.01746	0.00208
4.23000	0.00948	0.00113
4.23250	0.00222	0.00026
4.23500	-0.00300	-0.00036
4.23750	-0.00799	-0.00095
4.24000	-0.01056	-0.00126
4.24250	-0.01123	-0.00134
4.24500	-0.00688	-0.00082
4.24750	0.00014	0.00002
4.25000	0.01004	0.00119
4.25250	0.02047	0.00243
4.25500	0.03290	0.00391
4.25750	0.04429	0.00526
4.26000	0.05466	0.00650
4.26250	0.06159	0.00732
4.26500	0.06733	0.00800
4.26750	0.07126	0.00847
4.27000	0.07643	0.00908
4.27250	0.08188	0.00973
4.27500	0.08954	0.01064
4.27750	0.09769	0.01161
4.28000	0.10742	0.01277
4.28250	0.11519	0.01369
4.28500	0.12108	0.01439
4.28750	0.12233	0.01454
4.29000	0.12003	0.01426
4.29250	0.11209	0.01332
4.29500	0.10091	0.01199
4.29750	0.08666	0.01030
4.30000	0.07321	0.00870
4.30250	0.05974	0.00710
4.30500	0.04818	0.00573
4.30750	0.03666	0.00436
4.31000	0.02620	0.00311
4.31250	0.01479	0.00176
4.31500	0.00476	0.00057
4.31750	-0.00512	-0.00061
4.32000	-0.01279	-0.00152
4.32250	-0.01937	-0.00230
4.32500	-0.02252	-0.00268
4.32750	-0.02351	-0.00279
4.33000	-0.01983	-0.00236
4.33250	-0.01231	-0.00146
4.33500	0.00088	0.00011
4.33750	0.01590	0.00189
4.34000	0.03089	0.00367
4.34250	0.04099	0.00487
4.34500	0.04614	0.00548
4.34750	0.04426	0.00526
4.35000	0.03810	0.00453
4.35250	0.02731	0.00325
4.35500	0.01467	0.00174
4.35750	-0.00059	-0.00007
4.36000	-0.01530	-0.00182
4.36250	-0.02945	-0.00350
4.36500	-0.03918	-0.00466
4.36750	-0.04495	-0.00534
4.37000	-0.04531	-0.00538
4.37250	-0.04338	-0.00516
4.37500	-0.03868	-0.00460
4.37750	-0.03409	-0.00405
4.38000	-0.02933	-0.00349
4.38250	-0.02768	-0.00329
4.38500	-0.02801	-0.00333
4.38750	-0.03188	-0.00379
4.39000	-0.03705	-0.00440
4.39250	-0.04466	-0.00531
4.39500	-0.05151	-0.00612
4.39750	-0.05763	-0.00685
4.40000	-0.06024	-0.00716
4.40250	-0.06124	-0.00728
4.40500	-0.05914	-0.00703
4.40750	-0.05575	-0.00663
4.41000	-0.05005	-0.00595
4.41250	-0.04483	-0.00533
4.41500	-0.03868	-0.00460
4.41750	-0.03381	-0.00402
4.42000	-0.02906	-0.00345
4.42250	-0.02607	-0.00310
4.42500	-0.02297	-0.00273
4.42750	-0.02215	-0.00263
4.43000	-0.02250	-0.00267
4.43250	-0.02608	-0.00310
4.43500	-0.03130	-0.00372
4.43750	-0.03977	-0.00473
4.44000	-0.04845	-0.00576
4.44250	-0.05669	-0.00674
4.44500	-0.06106	-0.00726
4.44750	-0.06356	-0.00755
4.45000	-0.06359	-0.00756
4.45250	-0.06354	-0.00755
4.45500	-0.06112	-0.00726
4.45750	-0.05744	-0.00683
4.46000	-0.05124	-0.00609
4.46250	-0.04553	-0.00541
4.46500	-0.03962	-0.00471
4.46750	-0.03556	-0.00423
4.47000	-0.03091	-0.00367
4.47250	-0.02657	-0.00316
4.47500	-0.02047	-0.00243
4.47750	-0.01462	-0.00174
4.48000	-0.00768	-0.00091
4.48250	-0.00136	-0.00016
4.48500	0.00646	0.00077
4.48750	0.01402	0.00167
4.49000	0.02279	0.00271
4.49250	0.03067	0.00365
4.49500	0.03884	0.00462
4.49750	0.04421	0.00525
4.50000	0.04697	0.00558
4.50250	0.04441	0.00528
4.50500	0.03819	0.00454
4.50750	0.02770	0.00329
4.51000	0.01677	0.00199
4.51250	0.00576	0.00068
4.51500	-0.00199	-0.00024
4.51750	-0.00744	-0.00088
4.52000	-0.00827	-0.00098
4.52250	-0.00566	-0.00067
4.52500	0.00177	0.00021
4.52750	0.01046	0.00124
4.53000	0.02031	0.00241
4.53250	0.02847	0.00338
4.53500	0.03572	0.00425
4.53750	0.03926	0.00467
4.54000	0.04080	0.00485
4.54250	0.03942	0.00468
4.54500	0.03783	0.00450
4.54750	0.03495	0.00415
4.55000	0.03275	0.00389
4.55250	0.02974	0.00353
4.55500	0.02809	0.00334
4.55750	0.02639	0.00314
4.56000	0.02663	0.00316
4.56250	0.02652	0.00315
4.56500	0.02663	0.00316
4.56750	0.02471	0.00294
4.57000	0.02287	0.00272
4.57250	0.01958	0.00233
4.57500	0.01658	0.00197
4.57750	0.01236	0.00147
4.58000	0.00919	0.00109
4.58250	0.00552	0.00066
4.58500	0.00347	0.00041
4.58750	0.00133	0.00016
4.59000	0.00026	0.00003
4.59250	-0.00204	-0.00024
4.59500	-0.00345	-0.00041
4.59750	-0.00527	-0.00063

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4.60000	-0.00617	-0.00073
4.60250	-0.00855	-0.00102
4.60500	-0.01091	-0.00130
4.60750	-0.01535	-0.00182
4.61000	-0.02032	-0.00242
4.61250	-0.02684	-0.00319
4.61500	-0.03198	-0.00380
4.61750	-0.03691	-0.00439
4.62000	-0.04002	-0.00476
4.62250	-0.04359	-0.00518
4.62500	-0.04638	-0.00551
4.62750	-0.05041	-0.00599
4.63000	-0.05361	-0.00637
4.63250	-0.05743	-0.00683
4.63500	-0.06013	-0.00715
4.63750	-0.06305	-0.00749
4.64000	-0.06325	-0.00752
4.64250	-0.06156	-0.00732
4.64500	-0.05637	-0.00670
4.64750	-0.05009	-0.00595
4.65000	-0.04165	-0.00495
4.65250	-0.03395	-0.00404
4.65500	-0.02656	-0.00316
4.65750	-0.02190	-0.00260
4.66000	-0.01838	-0.00218
4.66250	-0.01744	-0.00207
4.66500	-0.01631	-0.00194
4.66750	-0.01574	-0.00187
4.67000	-0.01362	-0.00162
4.67250	-0.01154	-0.00137
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4.67750	-0.00367	-0.00044
4.68000	0.00158	0.00019
4.68250	0.00565	0.00067
4.68500	0.00958	0.00114
4.68750	0.01087	0.00129
4.69000	0.01118	0.00133
4.69250	0.00934	0.00111
4.69500	0.00778	0.00092
4.69750	0.00479	0.00057
4.70000	0.00229	0.00027
4.70250	-0.00080	-0.00010
4.70500	-0.00216	-0.00026
4.70750	-0.00340	-0.00040
4.71000	-0.00263	-0.00031
4.71250	-0.00157	-0.00019
4.71500	0.00181	0.00022
4.71750	0.00613	0.00073
4.72000	0.01280	0.00152
4.72250	0.01943	0.00231
4.72500	0.02786	0.00331
4.72750	0.03629	0.00431
4.73000	0.04575	0.00544
4.73250	0.05363	0.00637
4.73500	0.06049	0.00719
4.73750	0.06358	0.00756
4.74000	0.06490	0.00771
4.74250	0.06308	0.00750
4.74500	0.05955	0.00708
4.74750	0.05278	0.00627
4.75000	0.04560	0.00542
4.75250	0.03755	0.00446
4.75500	0.03178	0.00378
4.75750	0.02784	0.00331
4.76000	0.02787	0.00331
4.76250	0.02965	0.00352
4.76500	0.03416	0.00406
4.76750	0.03857	0.00458
4.77000	0.04328	0.00514
4.77250	0.04571	0.00543
4.77500	0.04759	0.00566
4.77750	0.04710	0.00560
4.78000	0.04565	0.00543
4.78250	0.04127	0.00490
4.78500	0.03595	0.00427
4.78750	0.02850	0.00339
4.79000	0.02163	0.00257
4.79250	0.01472	0.00175
4.79500	0.01057	0.00126
4.79750	0.00801	0.00095
4.80000	0.00861	0.00102
4.80250	0.01001	0.00119
4.80500	0.01353	0.00161
4.80750	0.01705	0.00203
4.81000	0.02169	0.00258
4.81250	0.02436	0.00290
4.81500	0.02519	0.00299
4.81750	0.02182	0.00259
4.82000	0.01658	0.00197
4.82250	0.00838	0.00100
4.82500	-0.00021	-0.00003
4.82750	-0.01022	-0.00122
4.83000	-0.01937	-0.00230
4.83250	-0.02862	-0.00340
4.83500	-0.03507	-0.00417
4.83750	-0.03969	-0.00472
4.84000	-0.04039	-0.00480
4.84250	-0.03910	-0.00465
4.84500	-0.03493	-0.00415
4.84750	-0.03058	-0.00363
4.85000	-0.02484	-0.00295
4.85250	-0.02011	-0.00239
4.85500	-0.01561	-0.00186
4.85750	-0.01421	-0.00169
4.86000	-0.01468	-0.00175
4.86250	-0.01830	-0.00218
4.86500	-0.02215	-0.00263
4.86750	-0.02695	-0.00320
4.87000	-0.03048	-0.00362
4.87250	-0.03442	-0.00409
4.87500	-0.03696	-0.00439
4.87750	-0.03937	-0.00468
4.88000	-0.03958	-0.00470
4.88250	-0.03969	-0.00472
4.88500	-0.03848	-0.00457
4.88750	-0.03834	-0.00456
4.89000	-0.03771	-0.00448
4.89250	-0.03796	-0.00451
4.89500	-0.03643	-0.00433
4.89750	-0.03410	-0.00405
4.90000	-0.02926	-0.00348
4.90250	-0.02456	-0.00292
4.90500	-0.01929	-0.00229
4.90750	-0.01569	-0.00187
4.91000	-0.01193	-0.00142
4.91250	-0.00984	-0.00117
4.91500	-0.00803	-0.00095
4.91750	-0.00802	-0.00095
4.92000	-0.00754	-0.00090
4.92250	-0.00778	-0.00093
4.92500	-0.00604	-0.00072
4.92750	-0.00374	-0.00045
4.93000	0.00041	0.00005
4.93250	0.00438	0.00052
4.93500	0.00957	0.00114
4.93750	0.01330	0.00158
4.94000	0.01627	0.00193
4.94250	0.01636	0.00194
4.94500	0.01574	0.00187
4.94750	0.01338	0.00159
4.95000	0.01215	0.00144
4.95250	0.01103	0.00131
4.95500	0.01205	0.00143
4.95750	0.01394	0.00166
4.96000	0.01902	0.00226
4.96250	0.02529	0.00301
4.96500	0.03347	0.00398
4.96750	0.04102	0.00488
4.97000	0.04911	0.00584
4.97250	0.05523	0.00656
4.97500	0.06045	0.00718
4.97750	0.06227	0.00740
4.98000	0.06160	0.00732
4.98250	0.05648	0.00671
4.98500	0.04935	0.00586
4.98750	0.03887	0.00462
4.99000	0.02713	0.00322
4.99250	0.01327	0.00158
4.99500	0.00061	0.00007
4.99750	-0.01118	-0.00133
5.00000	-0.01950	-0.00232
5.00250	-0.02578	-0.00306
5.00500	-0.02852	-0.00339
5.00750	-0.03042	-0.00362
5.01000	-0.03063	-0.00364
5.01250	-0.03122	-0.00371
5.01500	-0.03033	-0.00360
5.01750	-0.02969	-0.00353
5.02000	-0.02745	-0.00326
5.02250	-0.02516	-0.00299
5.02500	-0.02086	-0.00248
5.02750	-0.01640	-0.00195
5.03000	-0.01072	-0.00127
5.03250	-0.00659	-0.00078
5.03500	-0.00307	-0.00037
5.03750	-0.00231	-0.00028
5.04000	-0.00212	-0.00025
5.04250	-0.00398	-0.00047
5.04500	-0.00629	-0.00075
5.04750	-0.01054	-0.00125
5.05000	-0.01424	-0.00169
5.05250	-0.01843	-0.00219
5.05500	-0.02102	-0.00250
5.05750	-0.02388	-0.00284
5.06000	-0.02554	-0.00304
5.06250	-0.02799	-0.00333
5.06500	-0.02941	-0.00350
5.06750	-0.03137	-0.00373
5.07000	-0.03204	-0.00381
5.07250	-0.03316	-0.00394
5.07500	-0.03288	-0.00391
5.07750	-0.03288	-0.00391
5.08000	-0.03128	-0.00372
5.08250	-0.02970	-0.00353
5.08500	-0.02631	-0.00313
5.08750	-0.02290	-0.00272
5.09000	-0.01790	-0.00213
5.09250	-0.01338	-0.00159
5.09500	-0.00794	-0.00094
5.09750	-0.00372	-0.00044
5.10000	0.00077	0.00009
5.10250	0.00357	0.00042
5.10500	0.00638	0.00076
5.10750	0.00746	0.00089
5.11000	0.00868	0.00103
5.11250	0.00844	0.00100
5.11500	0.00867	0.00103
5.11750	0.00775	0.00092

ATTACHMENT C

REVISED FOUNDATION SETTLEMENT

KO 11Feb GKM
2/3/97
JFB 17Feb97

OSDF REVISED FOUNDATION SETTLEMENT CALCULATION

EXECUTIVE SUMMARY

This calculation package contains analyses for static foundation settlement, differential settlement, grade change, and tensile strain of the liner system for the On-Site Disposal Facility (OSDF).

The settlements are calculated using established geotechnical equations and procedures for elastic and consolidation settlement. The settlements are calculated for points within the OSDF at the center, crest, sump and toe of the facility. Differential settlements, change of grade, and tensile stain JFB in the liner system are calculated based on the total calculated settlements at selected points.

The analyses presented in this calculation package are identical to analyses presented in the Final Design Calculation Package for the OSDF, Revision G, Section 5. With the exception that the unit weight of the impacted material has been increased from 125 pcf to: (i) 129 pcf; and (ii) 143 pcf. This increase in impacted material unit weight is to account for the possibility of additional ~~steel~~ metal debris in the impacted material.

PURPOSE

The purpose of this document is to provide revised engineering calculations for the OSDF foundation and impacted material stability. This calculation package represents an amendment to the original calculations that are presented in Section 5 of the OSDF Final Design Calculation Package. The calculations contained in this document are performed with a revised unit weight for the impacted material. The unit weight of the impacted material is increased from 125 pcf to: (i) 129 pcf; and (ii) 143 pcf. The reason for this increased unit weight is to account for the effect of additional ~~steel~~ metal content in the impacted material on the stability of the OSDF.

The calculations contained in this package provide an estimate of settlement of the surface of the liner system due to consolidation and elastic settlement of the underlying soil materials. Included in the analysis is the elastic, primary consolidation, and secondary consolidation of the cohesive soils underlying the OSDF as well as the elastic settlement of the granular cohesionless soils underlying the OSDF. The analysis accounts for the variability in the foundation soils and the location of the ground water

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table. The effect of the perched water table was not considered to be significant for this analysis.

Based on the calculated settlements, an analysis will be made of the maximum change in liner system grade, the maximum differential settlement, and the maximum tensile strain expected in the liner system due to differential settlement.

PROCEDURE

The calculation procedure for foundation settlement is described in detail in the Design Criteria Package and is summarized here. The engineering properties of the underlying soil materials used in the analysis are provided in the Data Verification Package of the Final Design Calculations Package.

Calculations of the elastic and consolidation settlement of the foundation soils due to the load imposed by the OSDF are included. Widely known equations from elastic theory and consolidation theory are utilized.

Settlement is dependent upon:

- subsurface stratigraphy;
- subsurface material properties;
- load imposed by the landfill materials;
- geometry of the landfill; and
- location of the settlement point for calculation.

ANALYSIS

For a detailed discussion of the analysis and methods used in the calculations for the OSDF foundation settlement, differential settlement, grade change, and tensile strain, refer to the original calculation package.

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DATA VERIFICATION

As stated in the Purpose section of this calculation package, these calculations are performed to calculate settlement of the OSDF using an impacted material unit weight that is higher than that used in the original calculations. The increased unit weight represents the potential for a greater percentage of steel debris in the impacted material than was originally used in the calculations (i.e., original unit weight is 125 pcf).

The revised unit weights are as follows:

1 - revised unit weight equal to 129 pcf.

2 - revised unit weight equal to 143 pcf.

Refer to the original calculation package provided in document (i.e., OSDF Geotechnical-Settlement) for all other data used in these analyses. The data used in this analysis (with the exception of impacted material unit weight) are identical to the data used in the original analyses.

RESULTS

Based on the calculations, the following results are obtained.

Table 1. Case 1 Settlement

	Case 1 (γ 125 pcf)	Case 1 (γ 129 pcf)	Case 1 (γ 143 pcf)
Point A	2.27 (ft)	2.32 (ft)	2.50 (ft)
Point B	2.20 (ft)	2.25 (ft)	2.42 (ft)
Point C	1.25 (ft)	1.28 (ft)	1.38 (ft)
Point D	0.135 (ft)	0.138 (ft)	0.149 (ft)

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Table 2. Case 2 Settlement

	Case 2 (γ 125 pcf)	Case 2 (γ 129 pcf)	Case 2 (γ 143 pcf)
Point A	2.84 (ft)	2.89 (ft)	3.12 (ft)
Point B	2.76 (ft)	2.81 (ft)	3.03 (ft)
Point C	1.60 (ft)	1.63 (ft)	1.76 (ft)
Point D	0.23 (ft)	0.24 (ft)	0.26 (ft)

- Maximum calculated settlement: 3.12 ft (Case 2 Point A $\gamma = 143$ pcf)
- Maximum calculated tensile strain due to differential settlement

$\varepsilon_{max} = 0.01\%$ Satisfies limits of maximum allowable tensile strain for HDPE geomembranes as stated in Berg and Bonaparte (1992).

- Maximum calculated grade change due to differential settlement

Maximum change = 0.67% Post-settlement grade of leachate collection pipes will maintain positive flow. No grade reversal is calculated.

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JPB 1951-592

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GINA FATES MARTIN 97/2/13 — KARA OLEN 97 2 11

Written by: M. GLEASON Date: 95/2/15 Reviewed by: R.D.F. Date: 96/2/16

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~9.9~~ 23.1

Foundation Settlement - Calculation

Overburden from OSDF

$\gamma = 129$ pcf

- Assume Uniform unit weight - Average weight of impacted material and Final Cover System $\gamma = 143$ pcf = ~~125~~ pcf
- Calculate Settlement of Liner System for Final OSDF Configuration
- Maximum OSDF Height = 65 ft at CREST

  ≃ 55 ft at 6H:1V — 10H:1V Transition

  Assume Average Height = 60 ft.
- Overburden Pressure for analysis

  $\sigma_{n\,max} = 60\text{ft} \times \cancel{125}\ \text{pcf}$ (129 pcf, 143 pcf) $= \cancel{7500}$ psf

  $\gamma_{129} = 7740$ psf

  $\gamma_{143} = 8580$ psf
- For Foundation Settlement - assume load is placed at one time.
  - Calculate ultimate Foundation Settlement for this condition.

Calculate Foundation Settlement at Points A, B, C, + D

For Each Case

CASE 1	CASE 2
Clay Liner 3ft thick	Clay Liner 3ft thick
Brown Till 5 ft thick	Brown Till 10 ft thick
Gray Till 15 ft thick	Gray Till 45 ft thick
GMA Soil 210 ft thick	GMA Soils 175 ft Thick
Water Table at 70 ft Depth	Water Table at 70 ft Depth

Foundation Settlement

CASE 1 POINT A.

Layer 1 3ft Compacted Clay Liner.

$\gamma = 130$ $C_{\alpha e} = 0.0015$ $R_f = 0.9$ $e_p = 0.32$

$C_o = 0.43$ $\sigma_p = 1000$ psf $\nu = 0.475$

$C_c = 0.13$ $k = 150$ $S_u = 1200$

$C_r = 0.035$ $n = 1$ midpt. @ 1.5ft

* $\gamma_{WASTE} = 143$ pcf $\Rightarrow \Delta\sigma_v = 8580$ psf

$\gamma_{WASTE} = 129$ pcf $\Rightarrow \Delta\sigma_v = 7740$ psf

$I_f = 1.0$ * ~~$\Delta\sigma_v = 7500$ psf~~ $\sigma_1 = 1.5(130\text{pcf}) = 195$ psf

Assume $\sigma_3 = 0.8\sigma_1$ for undrained loading of clayey materials

$\sigma_3 = 156$ psf

$$E_{ut} = K p_a (\sigma_c/p_a)^n [1 - R_f(\sigma_1-\sigma_3)/2 s_u]^2$$

$$E_{ut} = 150(2117)(150/2117)^1 [1 - 0.9(195-156)/2(1200)]^2$$

$$E_{ut} = 21846 \text{ psf}$$

$$M = \frac{E_{ut}(1-\nu)}{(1+\nu)(1-2\nu)} = \frac{21846(1-0.475)}{1.475(1-0.95)} = 155,520$$

$$\Delta h_{i1} = (\overset{8580 \text{ or } 7740}{\cancel{7500}}/155,500)\,3\text{ft} = \cancel{0.145 \text{ ft}}$$

$\gamma = 143 \Rightarrow \Delta h = 0.166'$

$\gamma = 129 \Rightarrow \Delta h = 0.149'$

$$\Delta h_{p1} = 0.035 \frac{3}{1+0.43} \log \frac{1000}{195} + 0.13 \frac{3}{1+0.43} \log \frac{195 + \overset{8580 \text{ or } 7740}{\cancel{7500}}}{1000}$$

$$\Delta h_{p1} = \overset{0.052}{\cancel{0.052}} + 0.242 = \cancel{0.294} \text{ ft}$$

$\gamma = 143 \Rightarrow \Delta h = 0.309'$

$\gamma = 129 \Rightarrow \Delta h = 0.297'$

$$\Delta h_{s1} = 0.0015 \frac{3}{1+0.32} \log 1000/10 = 0.007 \text{ ft}$$

$$\Delta h_1 = \cancel{0.145} + \cancel{0.294} + 0.007 = \cancel{0.446 \text{ ft}}$$

$\gamma = 143$ pcf $\Rightarrow \Delta h_1 = 0.166 + 0.309 + 0.007 = \underline{0.482 \text{ ft}}$

$\gamma = 129$ pcf $\Rightarrow \Delta h = 0.149 + 0.297 + 0.007 = \underline{0.453 \text{ ft}}$

Written by: M. GLEASON (GINA KATES MARTIN) Date: 96/2/5 (97/12/17) Reviewed by: RRE (Kara Olen) Date: 96/2/16 (97 2 11)

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~9.9~~ 23.6

Foundation Settlement

CASE I Point A

Layer 2 5ft Brown Till

$\gamma = 135$	$e_o = 0.29$	$e_p = 0.22$	$R_f = 0.9$
$C_c = 0.075$	$C_r = 0.015$	$K = 175$	$\nu = 0.475$
$C_{\alpha e} = 0.0015$	$OCR = 1.7$	$n = 1$	$S_u = 1200$

$I_f = 1.0$ ~~$\Delta\sigma_v = 7500$ psf~~ $\gamma = 143 \Rightarrow \Delta\sigma_v = 8580$ psf

$\gamma = 129 \Rightarrow \Delta\sigma_v = 7740$ psf

At Midpoint of Layer @ 5.5ft $\sigma_o: (3 \times 130) + (2.5 \times 135) = 730$ psf

$\sigma_3 : 584$ psf

$$E_{ut} = 175\,(2117)\left(584/2117\right)^1\left[1 - 0.9\,(730-584)/2\,(1200)\right]^2$$

$$E_{ut} = 91{,}300$$

$$M = \frac{91300\,(1-0.475)}{1.475\,(.05)} = 650{,}000 \text{ psf}$$

$$\Delta h_{i_2} = \left(\cancel{7500}^{\,8580 \text{ or } 7740}/650{,}000\right) 5\text{ft} = \cancel{0.058\text{ft}}$$

$\gamma = 143$ pcf $\Rightarrow \Delta h_{i_2} = .066'$

$\gamma = 129$ pcf $\Rightarrow \Delta h_{i_2} = 0.060'$

$$\Delta h_{p_2} = 0.015\frac{5}{1+0.29}\log 1.7 + 0.075\frac{5}{1+0.29}\log\frac{730 + \cancel{7500}^{\,8580 \text{ or } 7740}}{1200}$$

$$\Delta h_{p_2} = \overset{0.0133}{0.013} + \cancel{0.245\text{ft}} = \cancel{0.258}\text{ ft}$$

$\gamma = 143$ pcf $\Rightarrow \Delta h = 0.272'$

$\gamma = 129$ pcf $\Rightarrow \Delta h = 0.260'$

$$\Delta h_{s_2} = 0.0015\frac{5}{1+0.22}\log 1000/20 = 0.012 \text{ ft}$$

Layer 2

~~$\Delta h = (0.058 + 0.256 + 0.012)$ ft~~

~~$\Delta h_2 = 0.326$ ft~~

$\gamma = 143_{pcf} \Rightarrow \Delta h = 0.066' + 0.272' + 0.012'$

$\Delta h = 0.350$ ft

$\gamma = 129$ pcf $\Rightarrow \Delta h = 0.060' + 0.260' + 0.012$

$\Delta h = 0.332$ ft

Written by: M. GLEASON Date: 96/2/15 (GINA KATES MARTIN 97/2/3) Reviewed by: R.D.F (KARA OLEN) Date: 96/2/16 (97 2 11)

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: 23

Foundation Settlement

CASE 1 Point A

Layer 3 7.5' gray till

$\gamma = 145$ $C_{\alpha} = 0.0013$ $R_f = 0.9$

$e_0 = 0.38$ $e_p = 0.29$ $\nu = 0.49$

$C_c = 0.074$ $K = 175$ $S_u = 1900$

$C_r = N/A$ OCR 1 $n = 1$

$I_F = 1.0$ $\cancel{\Delta\sigma_v = 7500\ psf}$

$\gamma = 143\ pcf \Rightarrow \Delta\sigma_v = 8580\ psf$

$\gamma = 129\ pcf \Rightarrow \Delta\sigma_v = 7740\ psf$

$\sigma_1 = 3(130) + 5(135) + 3.75(145) = 1600\ psf$ $\sigma_3 = 1300\ psf$

$E_{ut} = 175(2117)(1300/2117)^1[1-0.9(1600-1300)/2(1900)]^2$

$E_{ut} = 196{,}000$ $M = \dfrac{196{,}000(1-0.49)}{(1+0.49)(0.02)} = 3.35 \times 10^6$

$\Delta h_{i_3} = (\cancel{7500}\ 8580 \text{ or } 7740 / 3.35 \times 10^6)\ 7.5' = \cancel{0.017\ ft}$

$\gamma = 143\ pcf \Rightarrow \Delta h = 0.019'$

$\gamma = 129\ pcf \Rightarrow \Delta h = 0.017$

$\Delta h_{p_3} = 0.074 \dfrac{7.5}{1+0.38} \log\left(\dfrac{1600 + \cancel{7500}\ 8580 \text{ or } 7740}{1600}\right) = \cancel{0.304\ ft}$

$\gamma = 143\ pcf \Rightarrow \Delta h = 0.323$

$\gamma = 129\ pcf \Rightarrow \Delta h = 0.308$

$\Delta h_{s_3} = 0.0013 \dfrac{7.5}{1+0.29} \log 1000/10 = 0.015\ ft$

Layer 3 $\Delta h_{T_3} = 0.017\ ft + 0.304\ ft + 0.015\ ft = 0.336\ ft$

$\gamma = 143\ pcf \Rightarrow \Delta h_3 = 0.019 + 0.323 + 0.015 = \underline{0.357\ ft}$

$\gamma = 129\ pcf \Rightarrow \Delta h_3 = 0.017 + 0.308 + 0.015 = \underline{0.340\ ft}$

Layer 4 7.5' gray till parameters as in Layer 3 - Depth @ 19'

$I_F = 1.0$ $\Delta\sigma_v = \cancel{7500\ psf}$ $\sigma_1 = 390 + 675 + 11.25(145) = 2700\ psf$

$\gamma = 143$ $\Delta\sigma_v = 8580\ psf$ $\sigma_3 = 2150\ psf$

$\gamma = 129$ $\Delta\sigma_v = 7740\ psf$

$E_{ut} = 175 \cdot 2117 (2150/2117)^1 [1 - .9(2700-2150)/2(1900)]^2 = 284{,}600\ psf$

$M = 284{,}600\ psf \left(\dfrac{0.51}{1.49(0.02)}\right) = 284{,}600(17.1) = 4.9 \times 10^6\ psf$

$\Delta h_{i_4} = (\cancel{7500}\ 8580 \text{ or } 7740 / 4.9 \times 10^6)\ 7.5\ ft = \cancel{0.012\ ft}$

$\gamma = 143 \Rightarrow \Delta h = 0.013'$

$\gamma = 129 \Rightarrow \Delta h = 0.012'$

$\Delta h_{p_4} = 0.074 \dfrac{7.5}{1+0.38} \log\left(\dfrac{2700 + \cancel{7500}\ 8580 \text{ or } 7740}{2700}\right) = 0.232\ ft$

$\gamma = 143$ $\Delta h = 0.250'$

$\Delta h = 0.236'$

GINA KATES MARTIN 97/2/13 · KARA OLEW 97 2 11

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Written by: M. GLEASON Date: 96 / 2 / 5 (YY MM DD) Reviewed by: R.D.E. Date: 96 / 2 / 16 (YY MM DD)

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~09~~ 22.1

Foundation Settlement CASE I Point A

Layer 4 cont.

$$\Delta h_{s4} = 0.0013 \frac{7.5}{1+0.29} \log 1000/10 = 0.015 \text{ ft}$$

~~$\Delta h_{T4} = 0.012 + 0.232 + 0.015 = 0.259$ ft~~

$\gamma = 143 \Rightarrow \Delta h = 0.013 + 0.250 + 0.015 = 0.278$ ft

$\gamma = 129 \Rightarrow \Delta h = 0.012 + 0.236 + 0.015 = 0.263$ ft

Layer 5 12' Unsaturated GMA Soils $I_f = 1.0$ ~~$\Delta\sigma_v = 7500$ psf~~ $\gamma=143$ $\Delta\sigma_v = 8580$ psf; $\gamma=129$ $\Delta\sigma_v = 7740$ psf

$\gamma_T = 135$ pcf $\phi = 35$ $K = 900$ $n = 0.5$ $R_f = 0.7$ $\nu = 0.3$

$\sigma_1 = 3(130) + 5(135) + 15(145) + 6(135) = 4050$ psf

$\sigma_3 = \sigma_1(1-\sin\phi) = 1730$ psf $1-\sin\phi = 0.426$

$$E_t = K p_a (\sigma_3/p_a)^n [1 - R_f(1-\sin\phi)(\sigma_1-\sigma_3) / 2\sin\phi\,\sigma_3]^2$$

$$E_t = 900(2117)(1730/2117)^{1/2} [1 - 0.7(0.426)(4050-1730)/2(.574)1730]^2$$

$E_t = 7.3 \times 10^5$ psf

$$M = E_t \frac{1-0.3}{1+0.3(1-2(0.3))} = 7.3\times10^5 \text{ psf}(1.35) = 9.8\times10^5 \text{ psf}$$

$\Delta h_5 = (\cancel{7500}$ 8580 or 7740 $/9.8\times10^5)\ 12$ ft $=$ ~~0.091 ft~~

$\gamma = 143$ psf $\Delta h_5 = 0.105'$

$\gamma = 129$ psf $\Delta h_5 = 0.095'$

Layer 6 15' Unsaturated GMA soils $I_f = 1.0$

- Same parameters as layer 5 ~~$\Delta\sigma_v = 7500$ psf~~ $\gamma=143 \Rightarrow \Delta\sigma_v = 8580$ psf; $\gamma=129 \Rightarrow \Delta\sigma_v = 7740$ psf

$\sigma_1 = 4050$ psf $+ (6+7.5)(145) = 5870$ psf $\sigma_3 = 2500$ psf

$$E_t = 900(2117)(2500/2117)^{1/2}[1 - .7(.426)(5870-2500)/2(.574)(2500)]^2$$

$E_t = 8.7\times10^5$ $M = 8.7\times10^5(1.35) = 1.2\times10^6$ psf

$\Delta h_6 = (\cancel{7500}$ 8580 or 7740 $/1.2\times10^6$ psf$) \times 15$ ft ~~= 0.094 ft~~

$\gamma = 143$ pcf $\Rightarrow \Delta h_6 = 0.107'$

$\gamma = 129$ pcf $\Rightarrow \Delta h_6 = 0.097'$

GINA KATES MARTIN 97/2/3 — KARA OLEN 97 2 11

Written by: M. GLEASON Date: 96/2/5 Reviewed by: R.D.E Date: 96/2/16

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~99~~ 23.1 GEM

Foundation Settlement Case 1 Point A

Layer 7 20' Unsaturated GMA Depth = 60 ft @ midpoint

I_f = 1.0 ~~$\Delta\sigma_v$ = 7500 psf~~ $\sigma_1 = 5870 + 17.5(145) = 8200$ psf

$\gamma = 143$ $\Delta\sigma_v$ = 8580 psf σ_3 = 3500 psf

$\gamma = 129$ $\Delta\sigma_v$ = 7740 psf

$$E_t = 900(2117)\left(\frac{3500}{2117}\right)^{1/2}\left[1 - .7(.426)(8200-3500)/2(.574)3500\right]^2$$

$E_t = 1.0\times10^6$ $M = 1.0\times10^6 \times 1.35 = 1.4\times10^6$ psf

$\Delta h_7 = (\cancel{7500}$ 8580 or 7740 $/1.4\times10^6)$ 20 ft = ~~0.107~~ ft

$\gamma = 143 \Rightarrow \Delta h_7 = 0.123'$

$\gamma = 129 \Rightarrow \Delta h_7 = 0.111'$

Layer 8 20' Saturated GMA Depth = 80 ft @ midpoint
GWT @ 70'

$\sigma_1 = 8200 + 10(135) + 10(72.6)$
= 10,280 psf

I_f = 0.98 ~~$\Delta\sigma_v$ = 7350 psf~~ σ_3 = 4380 psf

$\gamma = 143$ $\Delta\sigma_v$ = 8408 psf

$\gamma = 129$ $\Delta\sigma_v$ = 7585 psf

$$E_t = 900(2117)\left(\frac{4380}{2117}\right)^{1/2}\left[1 - 0.35\right]^2 = 1.1\times10^6 \text{ psf}$$

$M = 1.1\times10^6$ psf $(1.35) = 1.5\times10^6$ psf

$\Delta h_8 = (\cancel{7350}$ 8408 or 7585 $/1.5\times10^6$ psf$)$ 20 ft = ~~0.098 ft~~

$\gamma = 143 \Rightarrow \Delta h_8 = 0.112$ ft

$\gamma = 129 \Rightarrow \Delta h_8 = 0.101$ ft

Layer 9

20' saturated GMA Depth to Mid Point = 100 ft

$\gamma = 143$ $\Delta\sigma_v$ = 8323 psf

I_f = 0.97 $\Delta\sigma_v$ = 7275 psf

$\gamma = 129$ $\Delta\sigma_v$ = 7508 psf

σ_1 = 10,280 psf + 20(72.6 psf) = 11730 psf σ_3 = 5000 psf

$$E_t = 900(2117)\left(\frac{5000}{2117}\right)^{1/2}\left[1 - .35\right]^2 = 1.24\times10^6 \text{ psf}$$

$M = 1.24\times10^6$ psf $\times 1.35 = 1.67\times10^6$ psf

$\Delta h_9 = (\cancel{7275}$ 8323 or 7508 $/1.67\times10^6) \times 20$ ft = ~~0.087~~ ft

$\gamma = 143 \Rightarrow \Delta h_9 = 0.100'$

$\gamma = 129 \Rightarrow \Delta h_9 = 0.090$

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GINA KATES MARTIN 97/2/13 KARA OLEN 97 2 11

Written by: M. GLEASON Date: 95 / 2 / 5 (YY MM DD) Reviewed by: R.D.E. Date: 96 / 2 / 16 (YY MM DD)

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: 9.9

23-1 GKM

Foundation Settlement Case 1 Point A

Layer 10

20' GMA soils Saturated Depth to midpoint = 120'

$\gamma = 143$ pcf $\Delta\sigma_v = 8237$ psf

$I_f = 0.96$ ~~$\Delta\sigma_v = 7200$ psf~~

$\gamma = 129$ pcf $\Delta\sigma_v = 7430$ psf

$\sigma_1 = 11730 + 20(72.6) = 13180$ $\sigma_3 = 5600$ psf

$E_t = 900(2117)\left(5600/2117\right)^{1/2}[1-.35]^2 = 1.31 \times 10^6$ psf

$M = 1.35\ E_t = 1.76 \times 10^6$ psf

$\gamma = 143$ pcf $\Rightarrow \Delta h_{10} = 0.094'$

8237 or 7430

$\Delta h_{10} = (\cancel{7200}/1.76 \times 10^6 \text{ psf})\ 20\text{ft} = \cancel{0.082}$ ft $\gamma = 129$ pcf $\Rightarrow \Delta h_{10} = 0.084'$

Layer 11 20' GMA Depth to midpoint = 140'

$I_f = 0.95$ ~~$\Delta\sigma_v = 7125$ psf~~ $\sigma_1 = 13180 + 20(72.6) = 14630$ psf

$\gamma = 143$ $\Delta\sigma_v = 8151$ psf $\sigma_3 = 6230$ psf

$\gamma = 129$ $\Delta\sigma_v = 7353$ psf

$E_t = 900(2117)\left(6230/2117\right)^{1/2}[1-.35]^2 = 1.38 \times 10^6$ psf

$M = 1.35\ E_t = 1.86 \times 10^6$ psf

8151 or 7353

$\Delta h_{11} = (\cancel{7125}/1.86 \times 10^6 \text{ psf})\ 20\text{ft} = \cancel{0.077}$ ft $\gamma = 143$ pcf $\Rightarrow \Delta h_{11} = 0.088'$

$\gamma = 129$ pcf $\Rightarrow \Delta h_{11} = 0.079'$

Layer 12 20' GMA Soils Mid pt depth @ 160ft

$I_f = 0.94$ $\Delta\sigma_v = 7050$ psf $\sigma_1 = 14630 + 20(72.6) = 16100$ psf

$\gamma = 143$ $\Delta\sigma_v = 8065$ psf

$\gamma = 129$ $\Delta\sigma_v = 7276$ psf $\sigma_3 = 6860$

$E_t = 900(2117)\left(6860/2117\right)^{1/2}[1-.35]^2 = 1.44 \times 10^6$ psf

$M = E_t \times 1.35 = 1.9 \times 10^6$ psf

8065 or 7276 $\gamma = 143$ pcf $\Delta h_{12} = 0.085'$

$\Delta h_{12} = (\cancel{7050}/1.9 \times 10^6)\ 20\text{ft} = \cancel{0.074}$ ft $\gamma = 129$ pcf $\Delta h_{12} = 0.077'$

GeoSyntec Consultants

Thomas [illegible]

GINA KATES MARTIN 97 / 2 / 13 KARA OLEN 97 2 11

Written by: M. GLEASON Date: 96 / 2 / 5 Reviewed by: RD.E. Date: 96 / 2 / 16

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~9.9~~ 23.1 6KM

Foundation Settlement CASE I Point A

Layer 13 30' GM Soils Mid depth @ 185 ft

$I_f = 0.92$ $\Delta\sigma_v = 6900\,psf$ $\sigma_1 = 16100 + 25(72.6) = 17910\ psf$

$\sigma_3 = 7640\ psf$

$E_t = 900(2117)\left(7640/2117\right)^{1/2}[1-.35]^2 = 1.52\times10^6$

$M = 1.35\ E_t = 2.06\times10^6\ psf$

$\Delta h_{13} = (\cancel{6900}/2.06\times10^6)\,30ft = 0.100\ ft$

σ 143pcf = 7893.6 = 0.115

σ 129 pcf = 7120 = 0.104

Layer 14 30' GM Soils Middepth @ 215 ft

$I_f = 0.89$ $\Delta\sigma_v = 6675\ psf$ $\sigma_1 = 17910 + 30(72.6) = 20,100\ psf$

$\sigma_3 = 8560\ psf$

$E_t = 900(2117)\left(8560/2117\right)^{1/2}[1-.35]^2 = 1.62\times10^6\ psf$

$M = E_t \times 1.35 = 2.2\times10^6\ psf$

$\Delta h_{13} = (6675/2.2\times10^6\ psf)\ 30ft = 0.091\ ft$

σ 143 = 7636 = 0.104

σ 129 = 6889 = 0.094

CASE I Point A

TOTAL SETTLEMENT

LAYER		SETTLEMENT ft $\gamma = 125pcf$	$\gamma = 143pcf$	$\gamma = 129$
1		.446	0.482	0.453
2		.326	0.350	0.332
3		.336	0.358	0.340
4	0.259	~~.232~~	0.278	0.26
5		.091	0.105	0.09
6	0.094	~~.096~~	0.107	0.097
7		.107	0.123	0.11
8		.095	0.112	0.101
9		.087	0.100	0.090
10		.082	0.094	0.084
11		.077	0.088	0.079
12		.074	0.085	0.077
13		.100	0.115	0.104
14		.091	0.104	0.094
TOTAL		~~2.24 ft~~ 2.265 ft	2.50'	2.32

FOUNDATION SETTLEMENT CASE 1 POINT B

Point B

BECAUSE INFLUENCE VALUES FOR LAYERS 1, 2, and 3 ARE IDENTICAL FOR POINT A, SETTLEMENT IS IDENTICAL.

			$\gamma = 143$ pcf	$\gamma = 129$ pcf
Layer 1	Δh_T =	~~0.446~~ ft	0.482 ft	0.453 ft
Layer 2	Δh_T =	~~0.326~~ ft	0.350 ft	0.332 ft
Layer 3	Δh_T =	~~0.336~~ ft	0.357 ft	0.340 ft

Layer 4 7.5 ft of Gray Till parameters obtained from Point A Calculation
Mid Point @ 19 ft.

$I_f = 0.996$ ~~$\Delta\sigma_v = 7470$ psf~~ $\sigma_1 = 2700$ psf

$\gamma = 143$ $\Delta\sigma_v = 8546$ psf

$\gamma = 129$ $\Delta\sigma_v = 7709$ psf

Elastic Settlement Parameters Et and M are unchanged.

$E_t = 284{,}600$, $M = 49 \times 10^6$ 8546 or 7709

$\gamma = 143 \Rightarrow \Delta h_{i4} = 0.013$

$\Delta h_{i4} = (\cancel{7470}/49\times10^6)\ 7.5\text{ ft} =$ ~~0.011 ft~~ $\gamma = 129 \Rightarrow \Delta h_{i4} = 0.012$

$\Delta h_{p4} = 0.094 \frac{7.5}{1+0.38} \log\left(\frac{2700 + \cancel{7470}}{2700}\right) =$ ~~0.231 ft~~ $\gamma = 143$ $\Delta h = 0.249$; $\gamma = 129$ $\Delta h = 0.236$

Δh_{s4} is not influenced by $\Delta\sigma_v$ $\therefore$ is equal to Δh_{s4} for Point A

~~$\Delta h_{T4} = 0.011 + 0.231 + 0.015$ ft $= 0.257$ ft~~

$\gamma = 143 \Rightarrow \Delta h_{T4} = 0.277$

$\gamma = 129 \Rightarrow \Delta h_{T4} = 0.263$

Layer 5 12' Unsaturated GMA Mid depth = 29 ft
values as in Layer 5 Point A

$M = 9.8\times10^5$ $I_f = 0.98$ ~~$\Delta\sigma_v = 7350$~~ $\gamma = 143$ $\Delta\sigma_v = 8408$ psf; $\gamma = 129$ $\Delta\sigma_v = 7585$ psf

$\Delta h_5 = (\cancel{7350}/9.8\times10^5)\ 12\text{ ft} =$ ~~0.090 ft~~

$\gamma = 143 \Rightarrow \Delta h_5 = 0.103$ ft

$\gamma = 129 \Rightarrow \Delta h_5 = 0.093$ ft

Layer 6 15' Unsaturated GMA Mid depth = 42.5 ft

$M = 1.2\times10^6$ $I_f = 0.96$ ~~$\Delta\sigma_v = 7200$ psf~~ $\gamma = 143$ $\Delta\sigma_v = 8237$ psf; $\gamma = 129$ $\Delta\sigma_v = 7430$ psf

$\Delta h_6 = (\cancel{7205}/1.2\times10^6)\ 15\text{ ft} = 0.090$ ft

$\gamma = 143 \Rightarrow \Delta h_6 = 0.103$ ft

$\gamma = 129 \Rightarrow \Delta h_6 = 0.093$ ft

GINA KATES MARTIN 97/2/3 KARA OLEN 97 2 11

Written by: M. GLEASON Date: 96/2/5 Reviewed by: RDE Date: 96/2/16

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~9.9~~ 23.6

Foundation Settlement CASE I Point B

Layer 7 20' Unsaturated GMA Mid depth = 60 ft

$M = 1.4\times10^6$ psf If = 0.94 ~~$\Delta\sigma_v$ = 7050 psf~~ γ=143 $\Delta\sigma_v$ = 8065 psf

γ=129 $\Delta\sigma_v$ = 7276 psf

Δh_7 = (~~7050~~/1.4×10⁶) 20' = ~~0.101 ft~~

γ=143 ⇒ Δh_7 = 0.115'

γ=129 ⇒ Δh_7 = 0.104'

Layer 8 20' Saturated GMA Mid depth = 80'

$M = 1.5\times10^6$ psf If = 0.916 ~~$\Delta\sigma_v$ = 6870 psf~~ γ=143 $\Delta\sigma_v$ = 7859 p.

γ=129 $\Delta\sigma_v$ = ~~7020~~ 7090 psf

Δh_8 = (~~6870~~/1.5×10⁶) 20' = ~~0.092 ft~~

γ=143 pcf ⇒ Δh_8 = 0.105'

γ=129 pcf ⇒ Δh_8 = 0.095'

Layer 9 20' Saturated GMA Mid depth = 100'

$M = 1.67\times10^6$ psf If = 0.9 ~~$\Delta\sigma_v$ = 6700~~ $\Delta\sigma_v$ = 7722 psf

$\Delta\sigma_v$ = 6966 psf

Δh_9 = (~~6700~~/1.67×10⁶ psf) 20 ft = ~~0.081 ft~~

γ=143 pcf = Δh_9 = 0.092'

γ=129 pcf = Δh_9 = 0.083'

Layer 10 20' GMA (Sat) Middepth @ 120'

$M = 1.76\times10^6$ psf If = 0.884 ~~$\Delta\sigma_v$ = 6630~~ $\Delta\sigma_v$ = 7585 psf

$\Delta\sigma_v$ = 6842 psf

~~Δh_{10} = (6630/1.76×10⁶ psf) 20 ft = 0.075 ft~~

γ=143 Δh_{10} = 0.086'

γ=129 Δh_{10} = 0.078'

Layer 11 20' GMA (Sat) Mid depth @ 140'

$M = 1.86\times10^6$ psf If = 0.85 ~~$\Delta\sigma_v$ = 6375 psf~~ $\Delta\sigma_v$ = 7293 psf

$\Delta\sigma_v$ = 6579 psf

Δh_{11} = (6375/1.86×10⁶ psf) 20' = 0.069 ft

γ=143 Δh_{11} = 0.078'

γ=129 Δh_{11} = 0.071'

Layer 12 20' GMA Sat Middepth @ 160'

$M = 1.9\times10^6$ psf If = 0.836 ~~$\Delta\sigma_v$ = 6270 psf~~ $\Delta\sigma_v$ = 7173 psf

$\Delta\sigma_v$ ~ 6471 psf

~~Δh_{12} = (6270/1.9×10⁶) 20' = 0.066 ft~~

γ=143 Δh_{12} = 0.076'

γ=129 Δh_{12} = 0.068'

GINA KATES MARTIN 97/2/3 KARA OLEN

Written by: M. GLEASON Date: 96/2/5 Reviewed by: R.P.E. Date: 96/2/16

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: ~~9.9~~ 23.1 GKM

Foundation Settlement Case 1 Point B

Layer 13 30' GMA Soils (Sat) Mid depth : 185 ft

$\Delta\sigma_v = 7036$ psf

$M = 2.06 \times 10^6$ psf $I_f = 0.82$ ~~$\Delta\sigma_v = 6150$ psf~~

$\Delta\sigma_v = 6348$ psf

~~$\Delta h_{13} = (6400 / 2.06 \times 10^6)\ 30' = 0.090$ ft~~

$\gamma = 143 \Rightarrow \Delta h_{13} = 0.102'$

$\gamma = 129 \Rightarrow \Delta h_{13} = 0.092'$

Layer 14 30' GMA (Sat) Mid depth = 215 ft

$\Delta\sigma_v = 6864$ psf

$M = 2.2 \times 10^6$ psf $I_f = 0.80$ ~~$\Delta\sigma_v = 6000$~~

$\Delta\sigma_v$ 6192 psf

~~$\Delta h_{14} = (6000 / 2.2 \times 10^6)\ 30' = 0.082$ ft~~

$\gamma = 143 \Rightarrow \Delta h_{14} = 0.094'$

$\gamma = 129 \Rightarrow \Delta h_{14} = 0.084'$

CASE 1 POINT B

TOTAL SETTLEMENT

LAYER	SETTLEMENT (FT) $\gamma = 125$	$\gamma = 143$	$\gamma = 129$
1	.446	0.482	0.453
2	.326	0.350	0.332
3	.336	0.357	0.340
4	.257	0.277	0.263
5	.090	0.103	0.093
6	.090	0.103	0.093
7	.101	0.115	0.104
8	.092	0.105	0.093
9	.081	0.092	0.083
10	.075	0.086	0.078
11	.069	0.078	0.071
12	.066	0.076	0.068
13	.090	0.102	0.093
14	.082	0.094	0.086
TOTAL	2.201 ft	2.42	2.23

* FOR REMAINING POINTS, USE RATIO OF SETTLEMENT (x) 000197

POINT A $\Rightarrow$ $\dfrac{\gamma = 129}{\gamma = 125} = \dfrac{2.32}{2.265} = \boxed{1.02}$ $\dfrac{\gamma_{143}}{\gamma_{125}} = \dfrac{2.50}{2.265} = \boxed{1.1}$

POINT B $\Rightarrow$ $\dfrac{\gamma = 129}{\ } = \dfrac{2.25}{\ } = \boxed{1.02}$ $\dfrac{\gamma_{43}}{\ } = \dfrac{2.42}{2.20} = \boxed{1.1}$

Written by: GINA KATES MARTIN Date: 97/2/3 Reviewed by: KARA OLEN Date: 97/11/2

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3400 Task No.: 23.1

CASE 1 POINT C

$\Delta s_{(\gamma=125)} = 1.252$ ft

$\Delta s_{(\gamma=129)} = (1.02)(1.252')$

$= 1.277$ ft

$\Delta s_{(\gamma=143)} = (1.1)(1.252')$

$= 1.377'$ ft

CASE 1 POINT D

$\Delta s_{(\gamma=125)} = 0.135$ ft

$\Delta s_{(\gamma=129)} = (1.02)(0.135$ ft$)$

$= 0.138$ ft

$\Delta s_{(\gamma=143)} = (1.1)(0.135')$

$= 0.149$ ft

CASE 2 POINT A

$\Delta s_{(\gamma=125)} = 2.836$

$\Delta s_{(\gamma=125)} = (1.02)(2.836)$

$= 2.893$ ft

$\Delta s_{(\gamma=143)} = (1.1)(2.836)$

$= 3.120$ ft

Written by: GINO KATES MARTIN Date: 97 / 2 / 3 Reviewed by: Thomas Wittig / KARA OLEN Date: 97 / 2 / 11

Client: FERMCO Project: OSDF Project/Proposal No.: GE 3900 Task No.: 23.1

CASE 2 POINT B

$$\Delta S_{(\gamma=125)} = 2.758 \text{ ft}$$

$$\Delta S_{(\gamma=129)} = (1.02)(2.758)$$

$$= \underline{2.813 \text{ ft}}$$

$$\Delta S_{(\gamma=143)} = (1.1)(2.758)$$

$$= \underline{3.033 \text{ ft}}$$

CASE 2 POINT C

$$\Delta S_{(\gamma=125)} = 1.598 \text{ ft}$$

$$\Delta S_{(\gamma=129)} = (1.02)(1.598 \text{ ft})$$

$$= \underline{1.630 \text{ ft}}$$

$$\Delta S_{(\gamma=145)} = (1.1)(1.598 \text{ ft})$$

$$= \underline{1.758 \text{ ft}}$$

CASE 2 POINT D

$$\Delta S_{(\gamma=125)} = 0.232 \text{ ft}$$

$$\Delta S_{(\gamma=129)} = (1.02)(0.232')$$

$$= \underline{0.237 \text{ ft}}$$

$$\Delta S_{(\gamma=143)} = (1.1)(0.232)$$

$$= \underline{0.255 \text{ ft}}$$

Written by: GINA KATES MARTIN Date: 97 / 2 / 3 (YY MM DD) Reviewed by: KARA OLEN Thomas Wb... Date: 97 / 2 / 11 (YY MM DD)

Client: FERMCO Project: OSDF Project/Proposal No.: GE3900 Task No.: 23.1

FOUNDATION SETTLEMENT SUMMARY

	CASE 1 (γ=125 pcf)	CASE 1 (γ=129 pcf)	CASE 1 (γ= 143 pcf)
POINT A	2.27 (ft)	2.32 (ft)	2.50 (ft)
POINT B	2.20 (ft)	2.25 (ft)	2.42 (ft)
POINT C	1.25 (ft)	1.28 (ft)	1.38 (ft)
POINT D	0.135 (ft)	0.138 (ft)	0.149 (ft)

	CASE 2 (γ=125 pcf)	CASE 2 (γ= 129 pcf)	CASE 2 (γ=143 pcf)
POINT A	2.84 (ft)	2.89 (ft)	3.12 (ft)
POINT B	2.76 (ft)	2.81 (ft)	3.03 (ft)
POINT C	1.60 (ft)	1.63 (ft)	1.76 (ft)
POINT D	0.23 (ft)	0.24 (ft)	0.26 (ft)

* NEGLECT POINT D FOR LINER SYSTEM ANALYSIS.

Written by: GINA KATES MARTIN Date: 97/2/8 Reviewed by: KARA OLEN Date: 97/2/11

Client: FERMCO Project: OSDF Project/Proposal No.: GE3900 Task No.: 23.1

DIFFERENTIAL SETTLEMENT, GRADE CHANGE, TENSILE STRAIN

CASE 1

POINTS A – B ($\gamma = 129$ pcf) $\Delta s = 0.07$ ft $L = 140$ ft

GRADE CHANGE = 0.05%

TENSILE STRAIN = $\varepsilon \cdot \frac{8}{3}\left(\frac{\Delta s}{L}\right)^2 100 = \frac{8}{3}\left(\frac{0.07}{140}\right)^2 100$

$\varepsilon = 6.7\text{E}-5\%$ ∴ VERY SMALL

POINTS A – B ($\gamma = 143$ pcf) $\Delta s = 0.08$ $L = 140$ ft

GRADE CHANGE = 0.06%

TENSILE STRAIN = $\varepsilon = \frac{8}{3}\left(\frac{0.08}{140}\right)^2 100$

$\varepsilon = 8.7\text{E}-5\%$ ∴ VERY SMALL

POINTS B – C ($\gamma = 129$ pcf) $\Delta s = 0.97$ $L = 190$ ft

GRADE CHANGE = 0.51%

TENSILE STRAIN = $\varepsilon = \frac{8}{3}\left(\frac{0.97}{190}\right)^2 100$

$\varepsilon = 7.0\text{E}-3\%$ ∴ VERY SMALL

POINTS B – C ($\gamma = 143$ pcf) $\Delta s = 1.04'$ $L = 190$ ft

GRADE CHANGE = 0.55%

TENSILE STRAIN = $\varepsilon = \frac{8}{3}\left(\frac{1.04}{190}\right)^2 100$

$\varepsilon = 8.0\text{E}-3\%$ ∴ VERY LOW

DIFFERENTIAL SETTLEMENT, GRADE CHANGE, TENSILE STRAIN

CASE 2

POINTS A-B (γ=129 pcf)

Δs = 0.08 ft L = 140 ft

GRADE CHANGE = 0.06%

TENSILE STRAIN = $8/3\,(0.08/140)^2\,100$

ε = 8.7E-5% ∴ VERY SMALL ✓

POINTS A-B (γ= 143 pcf)

Δs = 0.09 ft L = 140 ft

GRADE CHANGE = 0.06%

TENSILE STRAIN = $8/3\,(0.09/140)^2\,100$

ε = 1.1 E-4% ∴ VERY SMALL ✓

POINTS B-C (γ= 129 pcf)

Δs = 1.18' L = 190'

GRADE CHANGE = 0.62%

TENSILE STRAIN = $8/3\,(1.18/190)^2\,100$

ε = 0.01%

POINTS B-C (γ= 143 pcf)

Δs = 1.27' L = 190'

GRADE CHANGE = 0.67%

TENSILE STRAIN = $8/3\,(1.27/190)^2\,100$

ε = 0.01%

ATTACHMENT D

STRESS CONCENTRATION ON LINER SYSTEM

GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: Kara Olen Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE3900 Task No.: 23.1

JF 3/19/97

STRESS CONCENTRATION ON LINER SYSTEM

EXECUTIVE SUMMARY

PURPOSE OF ANALYSIS

The purpose of this analysis is to evaluate the impact of oversize steel objects for stress concentration on the geomembrane liner for the On-Site Disposal Facility (OSDF).

METHOD OF ANALYSIS

Stress on the geomembrane liner was evaluated for the worst case scenario of placing the steel objects directly on the select fill. Two loading conditions were evaluated, uniform load distributed over a rectangular surface for rhombic-like objects (e.g., gear box) and infinite vertical line loading on the surface of a semi-infinite mass for objects with a large length to diameter ratio (e.g., mill roll).

CONCLUSIONS

Stress Increase At Geomembrane Due To Gear Box Placed On Select Fill = 94 psf

Stress Increase At Geomembrane Due To Mill Roll Placed On Select Fill = 255 psf

The stress increase due to the placement of the given oversize steel objects is considered negligible due to being significantly less than the puncture resistance of the 80-mil textured geomembrane (13680-15120 psf).

KW 14 Feb

GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: Kara Olen Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE3900 Task No.: 23.1

JPB 19 Feb 97

STRESS CONCENTRATION ON LINER SYSTEM

CALCULATION PROCEDURES

INTRODUCTION

The purpose of this analysis is to evaluate the impact of oversize steel objects for stress concentration on the geomembrane liner for the On-Site Disposal Facility (OSDF). In particular, this package addresses the impact of placement of gear boxes and mill rolls directly on the select fill.

METHODS OF ANALYSIS

Stress concentrations will be calculated for the most massive objects having the least surface area in contact with the base of the OSDF. For rhombic-like massive objects, the gear box represents the most critical condition. For massive objects with a large length to diameter ratio, a mill roll represents the most critical condition.

Impact of Gear Box

The following approach recommended in Poulos and Davis (1974) assuming a uniform vertical loading over a rectangular area will be used to calculate the concentrated stress on the geomembrane liner resulting from a gear box being placed directly on the select fill:

- Calculate stress imposed by the gear box at the surface of the select fill (p).

$p = W_{box}/Area_{box}$ where $W_{box} = 6272$ lbs *(max)*

$Area_{box} = (4\text{ ft})*(4\text{ ft}) = 16\text{ft}^2$ *(contact area)*

000205

GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: Kara Olen Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE3900 Task No.: 23.1

JFB 19Feb97

- Determine influence factor (K_o) for corner (see Table 1 on page 6).

  $K_o = 0.060$ where $^b/_l = (2 \text{ ft})/(2 \text{ ft}) = 1$

  $^z/_l = (5 \text{ ft})/(2 \text{ ft}) = 2.5$

- Determine influence factor (K_o) for center by superposition.

  $K_{center} = 4 * K_o$

- Calculate stress at geomembrane under center of gear box (neglecting overburden).

  $\Delta\sigma_{z\ gear\ box} = p*K_{center}$

- Evaluate magnitude of stress increase due to placing gear box directly on select fill.

<u>Impact of Mill Rolls</u>

The following approach recommended in Poulos and Davis (1974) assuming an infinite vertical line load on the surface of a semi-infinite mass:

- Calculate stress imposed by the mill roll (p).

  $p = W_{mill\ roll}/Length_{mill\ roll}$ where $W_{mill\ roll}$ = 40080 lbs *(max)*

  $Length_{mill\ roll}$ = 20 ft

- Calculate stress at geomembrane under the mill roll (see page 10).

  $\Delta\sigma_{z\ mill\ roll} = (2p/\pi)*(z^3/R^4)$ where $z = R = 5$ ft

- Evaluate magnitude of stress increase due to placing mill roll directly on select fill.

000206

GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: Kara Olen Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE3900 Task No.: 23.1

JPB 19 Feb 97

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GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: Kara Olen Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE3900 Task No.: 23.1

STRESS CONCENTRATION ON LINER SYSTEM

DATA VERIFICATION

INTRODUCTION

The purpose of this analysis is to evaluate the impact of oversize steel objects in the On-Site Disposal Facility (OSDF) for stress concentration on the geomembrane liner. In particular, this package addresses the impact of placement of gear boxes and mill rolls directly on the select fill in the OSDF. The following data is utilized to perform the analyses described above.

GEAR BOX

Dimensional Range:

Height > 1.5 to **4** ft.

Width > 1.5 to **4** ft.

Length > 1.5 to **4** ft.

Weight = 331 to **6272** lbs.

NOTE: Dimensions in bold used for analysis

MILL ROLL

Dimensional Range:

Diameter: **1.5** to 2.5 ft.

Length > 10 to **20** ft.

Weight = 8650 to **40080** lbs.

NOTE: Dimensions in bold used for analysis

(KO) 14 Feb

GKM 2/13/97

Written By : Gina Kates Martin Date: 97/2/13 Reviewed by: KARA OLEN Date: 97/2/14

Client: Fermco Project: Fernald OSDF Project/Proposal No.: GE 3900 Task No.: 23.1

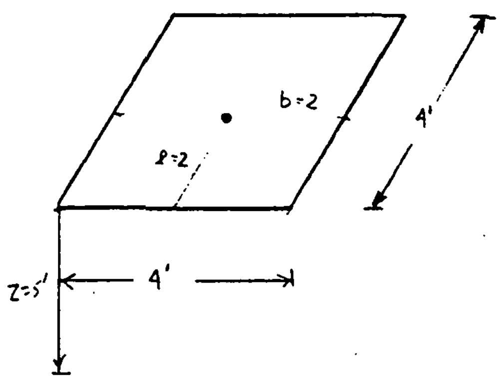
Table 1. Influence Factor

(Taken from Poulous and Davis, 1974)

VALUES OF K_o (Giroud, 1970)

z/ℓ \ b/ℓ	0	0.1	0.2	1/3	0.4	0.5	2/3	1	1.5	2	2.5	3	5	10	∞
0	0.000	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
0.2	0.000	0.137	0.204	0.234	0.240	0.244	0.247	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249
0.4	0.000	0.076	0.136	0.187	0.202	0.218	0.231	0.240	0.243	0.244	0.244	0.244	0.244	0.244	0.244
0.5	0.000	0.061	0.113	0.164	0.181	0.200	0.218	0.232	0.238	0.239	0.240	0.240	0.240	0.240	0.240
0.6	0.000	0.051	0.096	0.143	0.161	0.182	0.204	0.223	0.231	0.233	0.234	0.234	0.234	0.234	0.234
0.8	0.000	0.037	0.071	0.111	0.127	0.148	0.173	0.200	0.214	0.218	0.219	0.220	0.220	0.220	0.220
1	0.000	0.028	0.055	0.087	0.101	0.120	0.145	0.175	0.194	0.200	0.202	0.203	0.204	0.205	0.205
1.2	0.000	0.022	0.043	0.069	0.081	0.098	0.121	0.152	0.173	0.182	0.185	0.187	0.189	0.189	0.189
1.4	0.000	0.018	0.035	0.056	0.066	0.080	0.101	0.131	0.154	0.164	0.169	0.171	0.174	0.174	0.174
1.5	0.000	0.016	0.031	0.051	0.060	0.073	0.092	0.121	0.145	0.156	0.161	0.164	0.166	0.167	0.167
1.6	0.000	0.014	0.028	0.046	0.055	0.067	0.085	0.112	0.136	0.148	0.154	0.157	0.160	0.160	0.160
1.8	0.000	0.012	0.024	0.039	0.046	0.056	0.072	0.097	0.121	0.133	0.140	0.143	0.147	0.148	0.148
2	0.000	0.010	0.020	0.033	0.039	0.048	0.061	0.084	0.107	0.120	0.127	0.131	0.136	0.137	0.137
2.5	0.000	0.007	0.013	0.022	0.027	0.033	0.043	0.060	0.080	0.093	0.101	0.106	0.113	0.115	0.115
3	0.000	0.005	0.010	0.016	0.019	0.024	0.031	0.045	0.061	0.073	0.081	0.087	0.096	0.099	0.099
4	0.000	0.003	0.006	0.009	0.011	0.014	0.019	0.027	0.038	0.048	0.055	0.060	0.071	0.076	0.076
5	0.000	0.002	0.004	0.006	0.007	0.009	0.012	0.018	0.026	0.033	0.039	0.043	0.055	0.061	0.062
10	0.000	0.000	0.001	0.002	0.002	0.002	0.003	0.005	0.007	0.009	0.011	0.013	0.020	0.028	0.032
15	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	0.004	0.005	0.006	0.010	0.016	0.021
20	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.003	0.004	0.006	0.010	0.016
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.006

GEAR BOX



$z = 5'$ (DEPTH TO GEOMEMBRANE)

$b = 2'$

$\ell = 2'$

$$\left.\begin{array}{l} \frac{z}{\ell} = \frac{5}{2} = 2.5 \checkmark \\ \frac{b}{\ell} = \frac{2}{2} = 1 \checkmark \end{array}\right\} K_{CORNER} = 0.06 \checkmark$$

$K_{CENTER} = 4\ K_{CORNER}$

GKM 2/13/97

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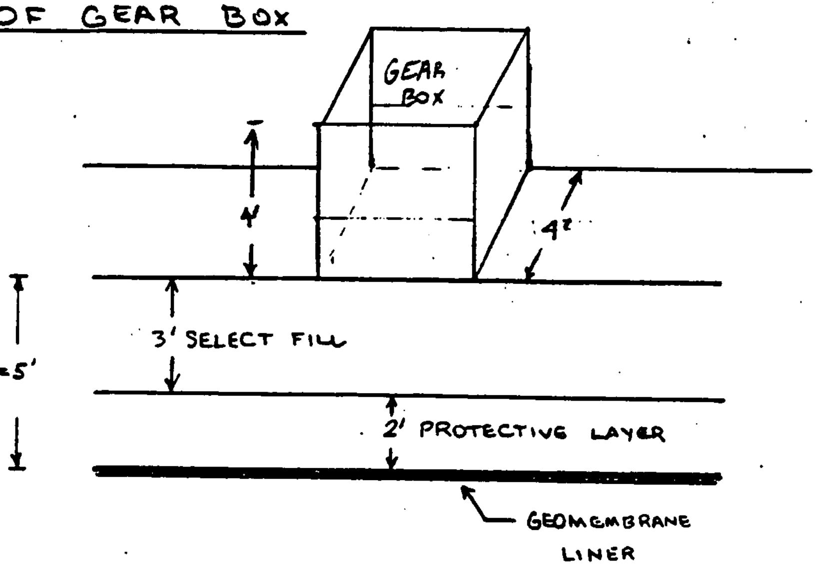
Client: FERMCO Project: FERNALD Project/Proposal No.: GE 3900 Task No.: 23.1

CONCENTRATION OF STRESS

CALCULATION RESULTS

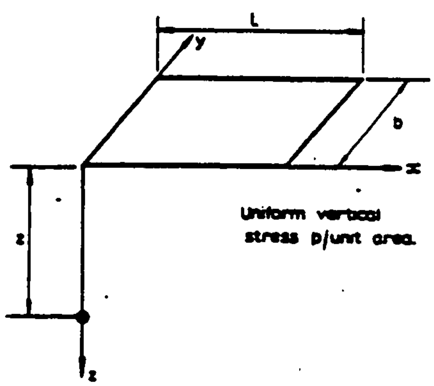
IMPACT OF GEAR BOX



W = 6272 lbs

FROM POULOS AND DAVIS (1974)

UNIFORM VERTICAL LOADING



UNDER CORNER:

$\sigma_z = p K_o$

WHERE $p = W/\text{AREA}$

K_o = INFLUENCE FACTOR FROM TABLE 1

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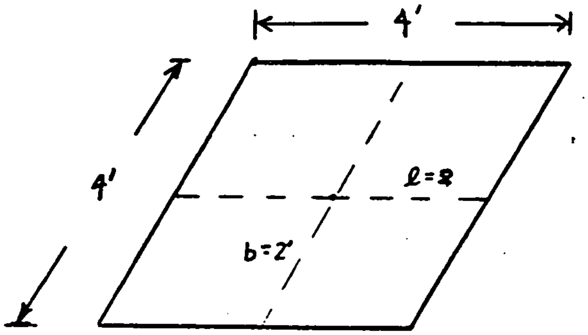
USE SUPERPOSITION TO FIND STRESS UNDER CENTER



FIND INFLUENCE FACTOR (K_o) FOR EACH SECTION AT CORNER

$b/l = 2/2 = 1$ ✓

$z/l = 5/2 = 2.5$ ✓

$K_o = 0.060$ ✓

$K_{CENTER} = 4 K_o$

$K_{CENTER} = 0.24$ ✓

INFLUENCE FACTOR
(TAKEN FROM POULOS AND DAVIS 1974)

VALUES OF K_o

(Giroud, 1970)

z/l \ b/l	0	0.1	0.2	1/3	0.4	0.5	2/3	1	1.5	2	2.5	3	5	10	∞
0	0.000	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250	0.250
0.2	0.000	0.137	0.204	0.234	0.240	0.244	0.247	0.249	0.249	0.249	0.249	0.249	0.249	0.249	0.249
0.4	0.000	0.076	0.136	0.187	0.202	0.218	0.231	0.240	0.243	0.244	0.244	0.244	0.244	0.244	0.244
0.5	0.000	0.061	0.113	0.164	0.181	0.200	0.218	0.232	0.238	0.239	0.240	0.240	0.240	0.240	0.240
0.6	0.000	0.051	0.096	0.143	0.161	0.182	0.204	0.223	0.231	0.233	0.234	0.234	0.234	0.234	0.234
0.8	0.000	0.037	0.071	0.111	0.127	0.148	0.173	0.200	0.214	0.218	0.219	0.220	0.220	0.220	0.220
1	0.000	0.028	0.055	0.087	0.101	0.120	0.145	0.175	0.194	0.200	0.202	0.203	0.204	0.205	0.205
1.2	0.000	0.022	0.043	0.069	0.081	0.098	0.121	0.152	0.173	0.182	0.185	0.187	0.189	0.189	0.189
1.4	0.000	0.018	0.035	0.056	0.066	0.080	0.101	0.131	0.154	0.164	0.169	0.171	0.174	0.174	0.174
1.5	0.000	0.016	0.031	0.051	0.060	0.073	0.092	0.121	0.145	0.156	0.161	0.164	0.166	0.167	0.167
1.6	0.000	0.014	0.028	0.046	0.055	0.067	0.085	0.112	0.136	0.148	0.154	0.157	0.160	0.160	0.160
1.8	0.000	0.012	0.024	0.039	0.046	0.056	0.072	0.097	0.121	0.133	0.140	0.143	0.147	0.148	0.148
2	0.000	0.010	0.020	0.033	0.039	0.048	0.061	0.084	0.107	0.120	0.127	0.131	0.136	0.137	0.137
2.5	0.000	0.007	0.013	0.022	0.027	0.033	0.043	0.060	0.080	0.093	0.101	0.106	0.113	0.115	0.115
3	0.000	0.005	0.010	0.016	0.019	0.024	0.031	0.045	0.061	0.073	0.081	0.087	0.096	0.099	0.099
4	0.000	0.003	0.006	0.009	0.011	0.014	0.019	0.027	0.038	0.048	0.055	0.060	0.071	0.076	0.076
5	0.000	0.002	0.004	0.006	0.007	0.009	0.012	0.018	0.026	0.033	0.039	0.043	0.055	0.061	0.062
10	0.000	0.000	0.001	0.002	0.002	0.002	0.003	0.005	0.007	0.009	0.011	0.013	0.020	0.028	0.032
15	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	0.004	0.005	0.006	0.010	0.016	0.021
20	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.003	0.004	0.006	0.010	0.016
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.006

GKM 2/13/97

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- UNIFORM VERTICAL STRESS

$$P = \frac{\text{WEIGHT}}{\text{AREA}} = \frac{6272 \text{ lbs}}{(4')(4')}$$

$$\underline{P = 392 \text{ psf}} \checkmark$$

- STRESS AT GEOMEMBRANE DUE TO GEAR BOX

$$\Delta\sigma_{z \text{ GEAR BOX}} = p \, K_{\text{CENTER}} = (392)(0.24)$$

$$\underline{\Delta\sigma_{z \text{ GEAR BOX}} = 94 \text{ psf}} \checkmark$$

INCREASED STRESS AT GEOMEMBRANE DUE TO GEAR BOX PLACED ON SELECT FILL CONSIDERED LOW AS COMPARED TO PUNCTURE RESISTANCE OF 80-mil HDPE (13690 - 15120 psf).

GRM 2/13/97

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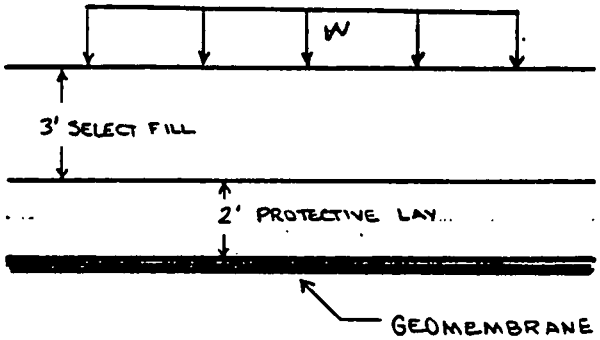
IMPACT OF MILL ROLL

W = 40,080 lbs

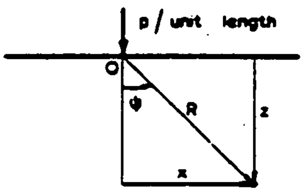
W = 40, 080 lbs

L = 20'



FROM POULOS AND DAVIS (1974)

INFINITE VERTICAL LINE LOAD
ON THE SURFACE OF A SEMI-
INFINITE MASS



WORST CASE PRESSURE INCREASE OCCURS
DIRECTLY BELOW THE LINE LOAD
∴ $X = 0$ AND $Z = R$.

$$\sigma_z = \frac{2p}{\pi} \frac{z^3}{R^4}$$

FOR MILL ROLLS:

$p = W/L = 40080\,lb / 20\,ft = 2004\ psf$ ✓

$z = R = 5'$

6KM 2/13/97

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- STRESS AT GEOMEMBRANE DUE TO ROLL MILL

$$\sigma_{z\,\text{ROLL MILL}} = \frac{2P}{\pi}\,\frac{z^3}{R^4} = \frac{2\,(2004\ \text{lb/ft})}{\pi\ 5}$$

$$\sigma_{z\,\text{ROLL MILL}} = 255\ \text{psf}$$

INCREASE IN STRESS AT GEOMEMBRANE DUE TO ROLL MILL PLACED ON SELECT WASTE CONSIDERED LOW AS COMPARED WITH PUNCTURE RESISTANCE (13680 – 15,120 psf)